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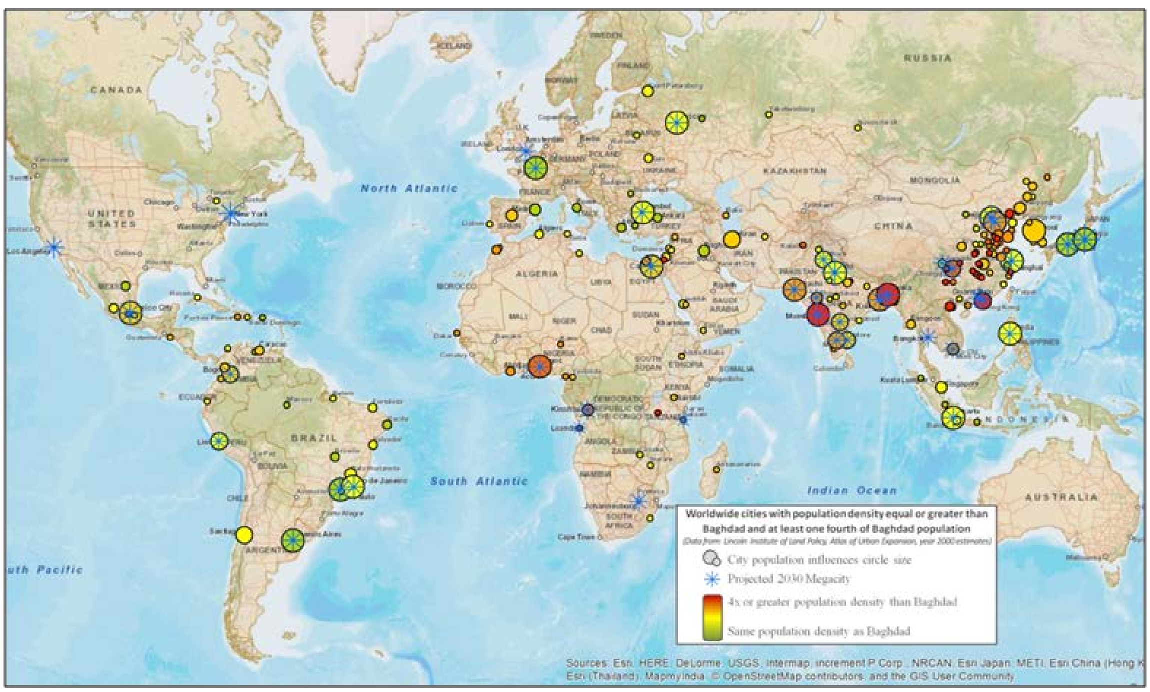
Center for the Advancement of Sustainability Innovations (CASI)

Extreme Environment Basing

Contingency Basing in Dense Urban and Megacity Environments

Dawn A. Morrison, Colin D. Wood, Timothy K. Perkins, and Carey L. Baxter

May 2016
Revised November 2016



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Abstract

The U.S. military may be required to operate in dense urban and megacity environments, which may pose significant challenges for contingency basing. This work reviews and analyzes the potential disconnect between existing doctrine, standard operating procedures, and the human geographic reality of dense urban environments and megacities as concerns contingency basing. The work: (1) characterizes 41 projected megacities using the Army Chief of Staff's Strategic Study Group's megacity typology, (2) performs crosswalk analysis between this characterization and existing contingency basing doctrine, (3) details doctrinal gaps, specifically those pertaining to site selection, logistics, and security, and (4) recommends future research to alleviate those gaps.

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Preface

This study was performed under the Center for the Advancement of Sustainability Innovations (CASI) Program for the U.S. Army Engineer Research and Development Center in coordination with the office of the Assistant Secretary of the Army Installations, Energy, and Environment (ASA(IE&E)) and the U.S. Army Installation Management Command (IMCOM). CASI was established by the U.S. Army Engineer Research and Development Center (ERDC) as a new capability in 2006, hosted at the Construction Engineering Research Laboratory (CERL) in Champaign, IL. CASI's mission is to focus ERDC expertise, technologies and partnerships toward helping the U.S. Army Corps of Engineers (USACE), the Army, and the Department of Defense (DoD) achieve more sustainable missions, facilities, and operations. The technical monitor and Associate Director of CASI was Franklin H. Holcomb.

The work performed by the Land and Heritage Conservation Branch (CN-C) of the Installations Division (CN), U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). The ERDC-CERL Principal Investigator (PI) was Dr. Dawn A. Morrison. The following ERDC-CERL researchers are gratefully acknowledged for their significant contributions to the content of this report: Dr. George W. Calfas, Dr. Charles R. Ehlschlaeger, Jeffrey A. Burkhalter, and Angela M. Rhodes. At the time of publication, Michael L. Hargrave was Chief, CEERD-CN-C; Michelle J. Hanson was Chief, CEERD-CN; and Alan B. Anderson was the Technical Director for Environmental Quality/Sustainable Lands and Ranges. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti and the Director was Dr. Ilker Adiguzel.

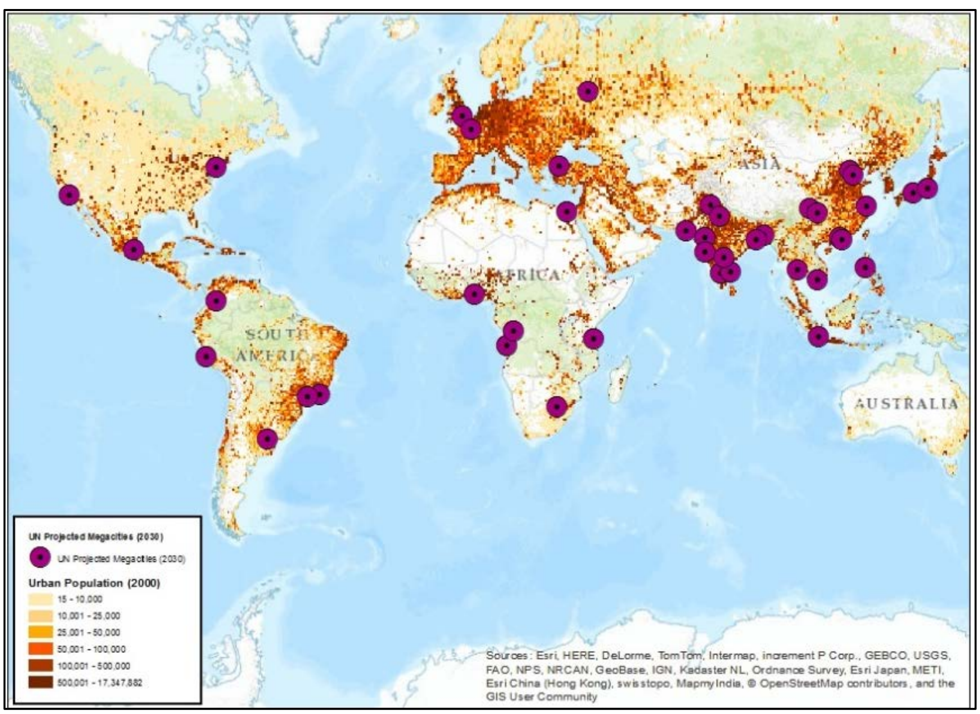
COL Bryan S. Green was Commander of ERDC, and Dr. Jeffery P. Holland was the Director.

1 Introduction

1.1 Background

Approximately 54% of the world's people are now urban residents; by 2050, 66% are expected to be urban (UN 2014). As urbanization increases, the United Nations (UN) projects that by 2030 there will be more than 41 megacities, the majority of which will be located in Africa and Asia—25 located specifically in the Asia-Pacific and Middle East regions (Figure 1). As rural life declines, these 41 cities alone will house approximately 9% of the world's population. More alarmingly, the number of people worldwide living in urban slums has increased by 33% since 1990 (UN-Habitat 2013). While many of these urban areas are not incredibly dense, a great many are. These places represent the extreme end of the urban spectrum for population density and city scale, thus qualifying them to be considered as an extreme human environment.

Figure 1. UN projected 2030 megacities with year 2000 population.



Source: UN (2014); Angel, Parent, Civco and Blei (2015).

As rural to urban migration continues to increase, experts expect more frequent requirements for the U.S. military to be involved in responding to conflicts and disasters in densely populated urban environments:

> While the U.S. military continues to protect U.S. national security interests across the globe, it must focus on protecting those interests where they are in most jeopardy. The greatest potential threats to those interests lie in Asia and the Middle East, and the U.S. Army's role extends to both (HQ TRADOC 2012).

Experts also expect that the increase in urbanization and urban density will pose many great challenges to military forces, especially in regard to issues of site placement and logistical interactions with local human and physical environments. Similarly, as more of the world population resides in littoral cities, natural disasters such as hurricanes, floods, health epidemics, and resource scarcity could pose support and recovery challenges.

Doctrine recognizes the potential for urban areas to become redoubts for enemy forces and acknowledges that "joint operations will require land forces capable of operating in congested and restricted urban terrain" (HQ TRADOC 2014a), thus acknowledging the likelihood and necessity of operating within megacities and dense urban environments. To operate in such austere environments, the military has adopted the use of contingency bases, defined as "an evolving military facility that supports the military operations of a deployed unit and provides the necessary support and services for sustained operations" (ATP 3-37.10).

Recent conflicts in Iraq and Afghanistan have shown the efficacy of contingency basing by U.S. and coalition forces; these conflicts involved both urban and rural environments, but nothing on the scale of megacities nor with the density of the most challenging urban environments. If the U.S. military needed to conduct Humanitarian Assistance and Disaster Relief (HADR), Counter Insurgency or Counter Terrorism operations, or respond to a civil war in such locations as Dhaka, Mexico City, or Manila, many vital questions would need immediate answers:

- How would the U.S. Army be positioned?
- What would the command and control environment look like in such circumstances, or how should it change to facilitate more sustainable operations within these extreme human environments?

- Would existing procedures continue to work in such dense urban environments, or must new strategies specifically targeted at addressing the hyper-urbanized environment be developed?
- With such densely populated areas, how difficult will it be to firmly establish a base of operations?
- Would current doctrine and guidance enable successful deployment to such an extreme human environment in terms of the physical logistics of situating a contingency base in a dense urban environment?
- What are the doctrine, manuals and guidance that the U.S. Army would rely on to establish operating bases in a dense urban environment?

Existing doctrine, tactics, techniques and procedures (TTPs) and guidance for contingency basing were not developed to support deployment in dense urban environments and/or megacities; however, it is the only official guidance available to the U.S. military for when it is ordered to operate in these environments. It has been noted that "[t]he Army's doctrinal and operational approaches to urban environments seek to shape them to yield conditions that allow the use of traditional techniques. This will not work in a megacity" (SSG 2014). Preliminary research has begun to reveal the inadequacy of current doctrine for conducting operations in a megacity or dense urban environment (SSG 2013).

The DoD is often accused of "planning for the last war" and not truly thinking outside of the box when it comes to preparing for future warfare environments and encounters (see for example, Ollivant [2015]). Indeed, when it comes to base camps, generally, "the lack of codified DoD or [Department of the Army] DA guidance has caused organizations' subordinate organizations, such as U.S. Central Command (CENTCOM) and U.S. Forces, Korea to develop their own guiding documents and principles. Examples are CENTCOM Regulation 415-1 ["The Sand Book"] and U.S. Forces, Korea Pamphlet 415-1" (HQ TRADOC 2009).

Megacities and dense urban environments are firmly on the horizon as likely and potential environments for future warfare and humanitarian engagements. Research continues on Phase Zero operations, to mitigate the need to enter a dense urban environment, and Phase Two operations, to enhance the conduct of military operations in a dense urban environment. Significant research, however, is required to address the pragmatic and lo-

gistical issues of physically placing and establishing U.S. troops in megacities and dense urban environments. Strategy, combat power, force planning, host nation partnering, maneuverability, etc. must be reevaluated within the context of such an extreme environment.

This work was undertaken to present a review and limited analysis of the disconnect between existing doctrine, standard operating procedures (SOPs), and the challenges posed to contingency basing in dense urban and megacity environments. This report applies a human geography perspective in the review of whether or not existing doctrine and standard operating procedures may provide adequate guidance for contingency basing in dense urban and megacity environments. Of particular interest is the relationship and interplay between and among the natural and built environments, the population and the doctrinal needs and requirements of contingency bases as they would be manifest in a dense urban/megacity environment. To facilitate this analysis, the megacity typology outlined by the Army Chief of Staff's Strategic Study Group (SSG [2013]) is implemented as an organizing framework for understanding the human geography domain of this type of extreme environment.

1.2 Objective

The objective of this work was to review and analyze the relationships and disconnects between existing Army doctrine, SOPs and the physical, human geographic reality of dense urban environments and megacities as concerns contingency basing, with a focus on the relationship and interplay between and among the natural and built environments, the population and the doctrinal needs, and requirements of contingency bases as they would be manifest in a dense urban/megacity environment.

1.3 Approach

The objectives of this work are met in the following tasks:

1. The terms "megacity," "dense urban environments," and "population as obstacle" are defined.
2. The UN's 41 projected megacities are identified and a vast matrix of data is assembled for each city.
3. Using select variables from this matrix of data, the SSG's megacity typology is implemented by creating a hierarchically ranked index of the cities

approximating the SSG loosely integrated to highly integrated megacity types. The index is based on normalized composite city scores derived from adapted z-scores that were averaged within the typology's three categories (flow capacity, infrastructure quality, and system type).

4. An index reflecting the level of risk associated with conflict and environmental hazards associated with each projected megacity is assembled and cross walked against the SSG's typology index to identify the megacities that present the highest risk/likelihood for future U.S. military intervention.
5. General themes that emerged from an annotation of doctrine for contingency basing—background and assumptions, basics, site selection, logistics, and security—are outlined and evaluated against the results of the Megacity Typology and Environmental Hazard and Conflict Risk indices.
6. The application of existing Army doctrine to contingency basing in hypothetical megacity and dense urban settings is discussed and analyzed, and doctrinal gaps are identified and detailed through real world examples.
7. Areas of future research that might alleviate these gaps are outlined and recommended.

2 Methods

2.1 Definitions

2.1.1 Megacity

The operating definition of a "megacity," as defined by the United Nations, is an urban or metropolitan area with a population of 10 million people or more. Oftentimes, megacities are not limited to the "city proper" contained within municipal political boundaries, but are rather the urban agglomeration of the surrounding metropolitan area. In some instances, the megacity is formed by the conurbation of two or more urban areas that converge and overlap, such as the New York City-Newark area.

2.1.2 Dense urban environment

There is currently no standardized, metric-based definition for what constitutes a "dense urban environment," or even for determining the point at which an area switches from "urban" to "dense urban." The U.S. Census Bureau defines the minimum threshold to be considered urban as an area with 50,000 or more people with a minimum threshold of 1000 people per square mile, but does not define anything beyond the dichotomy of urban/rural (U.S. Census Bureau 2015). The fields of urban planning and urban design often factor in floor area ratio (FAR) and dwelling units per area (DU/Area) along with population density, and then examine the persistence of these metrics over scale, ranging from block or developmental parcel upwards to neighborhood, then district to city or region.*

Using these metrics, one can begin to understand dense urban environments as places where either all three metrics—FAR, DU/Area and Population—are high (e.g., high rise districts of Tokyo, London or New York), or where DU/Area and Population remain high while FAR decreases (e.g., favelas of Rio de Janeiro or the slums of Dhaka). Employing a combination of these metrics may help provide a more accurate determination of urban density as they normalize population by infrastructure capacity, thereby making it possible to better identify and measure dense urban environments for the purposes of planning and execution of military operations. These metrics enable planners to understand the spatial distribution of the

* For a good explanation of these metrics, see MIT's Density Atlas (2011) project.

density and whether it is stacked vertically (high FAR, DU/AREA and Population) or concentrated at ground level (low FAR, high DU/Area and Population). For military purposes, understanding the impact of increasing density will significantly impact all aspects and phases of operations For example, reduced street widths and limited carrying capacity in dense urban environment may preclude or limit mounted movement (Figures 2, 3, and 4).

Figure 2. Old Dhaka (Left), and Old Dhaka aerial view; dense urban environment (right) (low FAR, high DU and high Population).

Figure 3. Favelas of Rio de Janeiro, dense urban environment (left—low FAR, high DU and high Population), and (Right—low FAR, high DU & high Population next to a high FAR, high DU and moderate Population).


Figure 4. Residential area of downtown Tokyo (left) and Hong Kong (right) (high FAR, high DU and high Population).

2.1.3 Population as an obstacle

During the conflicts in Iraq and Afghanistan, U.S. military leaders placed additional attention on civil considerations and to the understanding of population. The local population is a dynamic, organic landscape feature that occupies space and that can appear as an obstacle to mission objectives much the same as static elements in the built environment. One might argue that the population is more challenging than typical physical obstacles due to its temporality, unpredictability, and interactive effect. Unlike buildings, populations move; they ebb and flow through the physical environment on dynamic temporal schedules that have daily, weekly, monthly, seasonal, and yearly variance.

In the megacity, and particularly in dense urban environments, the population is an incredibly complex factor that results in novel challenges for contingency basing. As discussed in the next section, people are at the root of every variable used to create a megacity typology. As such, the analysis of population should be comparable in sophistication as the current analyses of infrastructure and terrain, with respect to their impacts on mobility, lines of sight, potential threat zones, and other mission planning concerns.

2.2 Megacity typology

2.2.1 SSG framework and typology

To help better explore the human geography of megacities and dense urban environments, this work implemented the megacity typology presented by the SSG (2013). The SSG report provides examples of how various existing megacities exemplify the framework and typology they have

developed. It discusses how existing doctrine may not work well to support military operations in such extreme environments as megacities. The SSG report, however, does not specifically focus on the doctrinal capacity related to contingency basing; it primarily focuses on the challenges megacities pose to U.S. military capabilities to conduct phased operations.

The SSG proposes a framework for understanding megacities based on five characteristics: (1) Context, (2) Scale, (3) Density, (4) Connectedness, and (5) Flow. This framework forms the foundation for a typology that organizes megacities based on the level of integrated systems found in each megacity (Highly Integrated, Moderately Integrated, and Loosely Integrated). Integration, in turn, is based on the level of formality of systems (formal versus informal), on the quality of infrastructure, and on the degree of regulation that is applied to the flow capacity of goods, resources, people, and information.

To implement the SSG megacity typology, this work assembled a matrix of data* from open sources for each of the projected 41 megacities (Table 1). Metrics collected in the data matrix were selected to cover the five characteristics above. For example, data were collected on such topics as governance, rule of law, stability, quality of life, politics, airports, seaports, railroads, roads, economic growth and performance, communication, demographics and other associated human geography variables. Much of the data used to compile the index are drawn from regularly updated metrics so that the operationalized framework has the ability to remain current over time. Select variables (Table 2) were then identified from this data to represent the integration categories described by the SSG to define its typology: system types, infrastructure quality and regulated flow capacity. The source data values were adapted to z-scores (a standard score measuring how far each data point is above or below the mean) based on the values given for each of the 41 megacities. The z-scores were averaged within each typology category (flow capacity, infrastructure quality, and system type). The three typology category averages were then averaged to yield composite city scores. Finally, the city scores were normalized to a scale from 1 to 3, approximating the SSG megacity typology, loosely integrated to highly integrated.

* Data is available upon request.

Table 1. List of city-level variables collected and considered *(**variable at country level).*

Variable	Description
2015 Population	2008 Est. Gross Domestic Product (GDP) ($BN) Purchasing Power Parity (PPP) Adjusted
2030 Population	Estimated GDP in 2025 ($BN) PPP-Adjusted
Size (km2) of City	Real GDP growth rate (%pa: 2008-25)
Population Density (people/km2) 2015	Economist Intelligence Unit (EIU) Livability Survey 2008
Population Density (people/km2) 2030	Proportion of Urban Households with Access to main floor materials 1990, 2003
Average Annual Rate of Change (%) in population from 2010-2015	Proportion of Urban Households with Access to sufficient living area 1990, 2003
Average Annual Rate of Change (%) in population from 2025-2030	Proportion of Urban Households with Access to safe water source 1990, 2003
Population Density Change (%) 1988-2000	Proportion of Urban Households with Access to improved sanitation 1990, 2003
Urban Expansion (%) 1988-2000	Major Port City (Y/N)
Urban Fragmentation: Built Up Area 1988-2000	Distance from Capital (km)
Urban Fragmentation: Openness Index 1988-2000	Nearest National Border (km)
Urban Compactness (Proximity) 1988-2000	Distance to Major Port (km)
Built Up Area (Hectares) 1988-2000	Littoral (Y/N)
Urbanized Open Space (Hectares) 1988-2000	Mountainous (Y/N)
City Prosperity Index	** Cell Phone Saturation 2013
Global Cities Index 2014	** Internet Users (per 100 people)
Global Power Index (2008 & 2009)	** Total Vehicle Registrations (country) 2006
Quality of Living City Rankings	** Total Vehicle Registrations (country) 2010
Rank Economic Performance 2013-2014	** Quality of Infrastructure-Air Transport
Development Status	** Quality of Infrastructure-Port
GDP per Capita Change 2013-2014	** Quality of Infrastructure-Railroad
Employment Change 2013-2014	** Quality of Infrastructure-Roads
Richest Cities in the World by Purchasing Power Rankings 2011, 2012	** Quality of Infrastructure-Overall
Richest Cities in the World by Gross Wages Rankings 2011, 2012	** % Change Total Vehicle Registrations (country) 2006-2010
iPod Index Rankings 2009	** Fragile State Index 2015
iPod Index Work Hours Needed 2009	** Rule of Law 2015
2014 GDP ($BN) PPP-adjusted	** Functioning Government 2015

Table 2. Variables used to implement the SSG Megacity Typology.

						Source Data				
Typology Category	Subcategory	Directionality	Resolution	Data Element	Data Source	Max	Min	Average	Median	Std Dev
Flow Capacity	Goods	Higher is better	City	2008 Est. GDP ($BN) PPP-Adjusted	Pricewaterhouse Coopers UK Economic Outlook, Nov. 2009	1,479.0	8.0	238.4	110.0	325.0
Flow Capacity	Information(a)	Higher is better	Country	Cell Phone Saturation 2013	ITU: Mobile-cellular telephone subscriptions per 100 inhabitants (2013)	162.5	41.8	96.3	88.7	28.6
Flow Capacity	Information(b)	Higher is better	Country	Internet Users (per 100 people) 2015	Quality of Government Institute, Jan. 2015 Standard Data	85.0	0.7	31.0	31.4	23.6
Flow Capacity	People	Lower is better	City	Average annual rate of population change (%) 2010-2015	UN Urban Agglomerations 2014	5.6	0.2	2.5	2.8	1.4
Flow Capacity	Resources	Lower is better	City	Economic Performance Rank 2013-2014	Global Metromonitor 2014	300.0	3.0	117.4	87.0	88.7
Infrastructure Quality	Overall	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Overall Infrastructure 2015	Quality of Government Institute, Jan. 2015	6.4	2.8	4.1	3.8	0.9
Infrastructure Quality	Air	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Air Transport 2015	Quality of Government Institute, Jan. 2015	6.2	3.0	4.6	4.5	0.8
Infrastructure Quality	Port	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Port 2015	Quality of Government Institute, Jan. 2015	5.8	2.6	4.2	4.0	0.8
Infrastructure Quality	Railroad	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Railroad 2015	Quality of Government Institute, Jan. 2015	6.6	1.6	3.7	4.4	1.4
Infrastructure Quality	Roads	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Roads 2015	Quality of Government Institute, Jan. 2015	6.5	2.3	4.0	3.5	1.1
Infrastructure Quality	Roads	Higher is better	City	Livability Assessment 2008	EIU 2008 Livability Survey	95.2	36.9	68.9	69.1	16.2
Systems	Governance	Higher is better	Country	Functioning Government 2015	Quality of Government Institute, Jan. 2015	12.0	1.0	6.2	7.0	3.3
Systems	Politics/ Culture/ Info/ Human capital/ Business	Higher is better	City	Global Cities Index Rankings 2010	AT Kearney Global Cities Index	6.2	0.3	2.2	1.7	1.6
Systems	Quality of Life (QOL)	Lower is better	City	Quality of Living (QOL) 2015	Mercer's 2015 City Rankings	223.0	27.0	132.6	136.0	50.6
Systems	Rule of Law	Higher is better	Country	Rule of Law 2015	Quality of Government Institute, Jan. 2015	15.0	-	7.1	7.0	4.2
Systems	Stability	Lower is better	Country	Fragile State Index 2015	Fund for Peace, 2015	109.7	33.4	73.2	76.4	19.5

Notably, this ranking represents a prototype quality level of assessment, quickly prepared to explore and demonstrate the diversity of environments and challenges in the projected megacities. One limitation of the assessment is that, aside from hierarchically nesting selected variables under the three major components of the typology (i.e., formal/informal systems, infrastructure quality, and flow regulation), variables were unweighted and covariance was not addressed. A second limitation was the use of country-level data for infrastructure assessment of the cities. The approach, nonetheless, yields a preliminary assessment of the projected megacities according to the SSG megacity typology (Table 3). Appendix A includes full details of the initial data and transformations.

Table 3. Projected megacities typology scores (sorted by score).

City (Urban Agglomeration)	Country	Typology Score*
Tokyo	Japan	3.0
London	United Kingdom	3.0
New York-Newark	United States of America	3.0
Paris	France	2.9
Los Angeles-Long Beach-Santa Ana	United States of America	2.8
Kinki M.M.A. (Osaka)	Japan	2.7
Johannesburg	South Africa	2.2
Istanbul	Turkey	2.2
Buenos Aires	Argentina	2.0
Ciudad de México (Mexico City)	Mexico	2.0
Krung Thep (Bangkok)	Thailand	2.0
Shenzhen	China	1.9
Shanghai	China	1.9
Kolkata (Calcutta)	India	1.9
Mumbai (Bombay)	India	1.9
Lima	Peru	1.9
Beijing	China	1.9
Chennai (Madras)	India	1.9
Hyderabad	India	1.9
Delhi	India	1.9
Chengdu	China	1.9
Rio de Janeiro	Brazil	1.8
Ahmadabad	India	1.8
Moskva (Moscow)	Russian Federation	1.8
Jakarta	Indonesia	1.8
Chongqing	China	1.8
São Paulo	Brazil	1.8
Bangalore	India	1.8
Guangzhou, Guangdong	China	1.8

City (Urban Agglomeration)	Country	Typology Score*
Al-Qahirah (Cairo)	Egypt	1.8
Tianjin	China	1.8
Manila	Philippines	1.7
Bogotá	Colombia	1.7
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	1.6
Lahore	Pakistan	1.5
Karachi	Pakistan	1.5
Dar es Salaam	United Republic of Tanzania	1.4
Lagos	Nigeria	1.4
Dhaka	Bangladesh	1.3
Luanda	Angola	1.3
Kinshasa	Democratic Republic of the Congo	1.0
*3 = highly integrated, 2 = moderately integrated, 1 = loosely integrated		

2.2.2 Conflict and environmental risk hazards

The operationalized megacity framework was further connected to data compiled from the Global Conflict Risk Index (GCRI 2014) and NASA's Socioeconomic Data and Applications Center (SEDAC) (NASA 2015) to assess the level of risk associated with conflict and environmental hazards for each projected megacity (Figures 5 and 6). According to the GCRI, more than 70% of the projected megacities are situated in countries with a high probability for conflict in the near future. Similarly, over half of the projected megacities are at elevated risk for environmental hazards (e.g., drought, flood, cyclone, landslide, and earthquake), including both highly integrated cities such as Tokyo and Los Angeles, as well as moderately and loosely integrated cities such as Kolkata, Bogotá, Lahore and Manila. Moscow, Kinshasa, and Cairo are the only projected megacities to *not* have a moderate to elevated environmental risk according to SEDAC data (NASA 2015). These findings support the June 2014 SSG report, which posited that instability and environmental stressors are likely to be what leads to U.S. military intervention in a megacity. Since 1980, the U.S. military has responded to a wide variety of threats and operations impacting national security, but the majority of these operations have consisted of humanitarian assistance/disaster relief (HADR) operations, both CONUS and OCONUS, rather than major combat operations (Sukman 2015). With climate change and sea-level rise, one should expect to see drastic change in many of the world's littoral areas in the coming decades, and a U.S. response to follow.

Figure 5. Probability of conflict (0–1) assessed at the country level (megacities sorted by integration score; green indicates low probability, red indicates high probability).

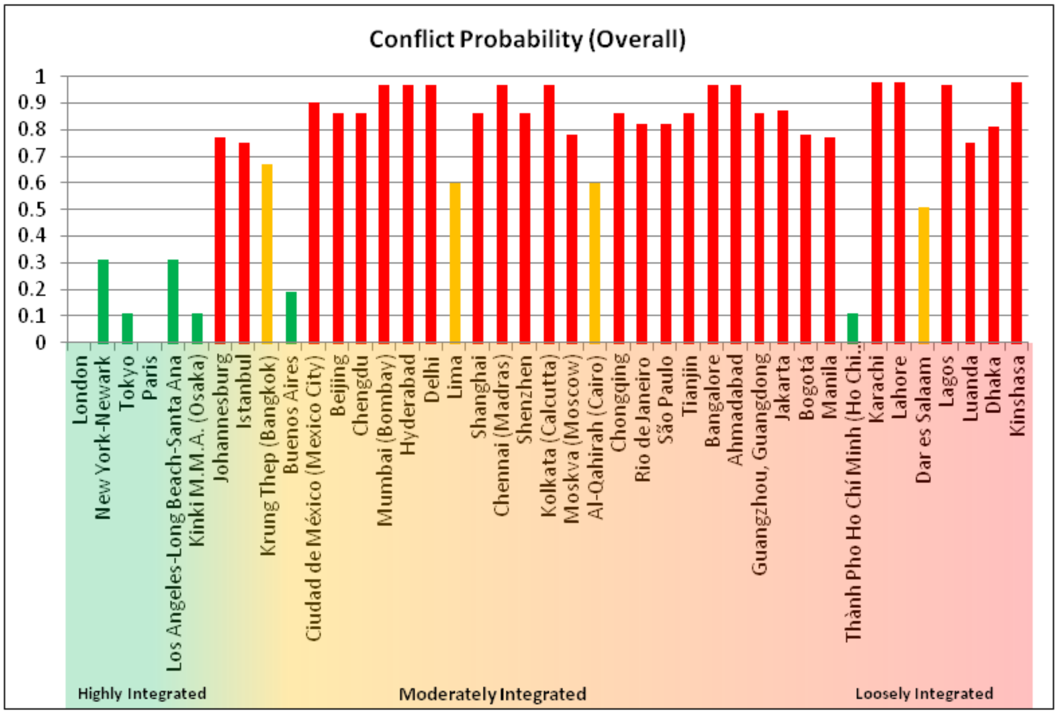
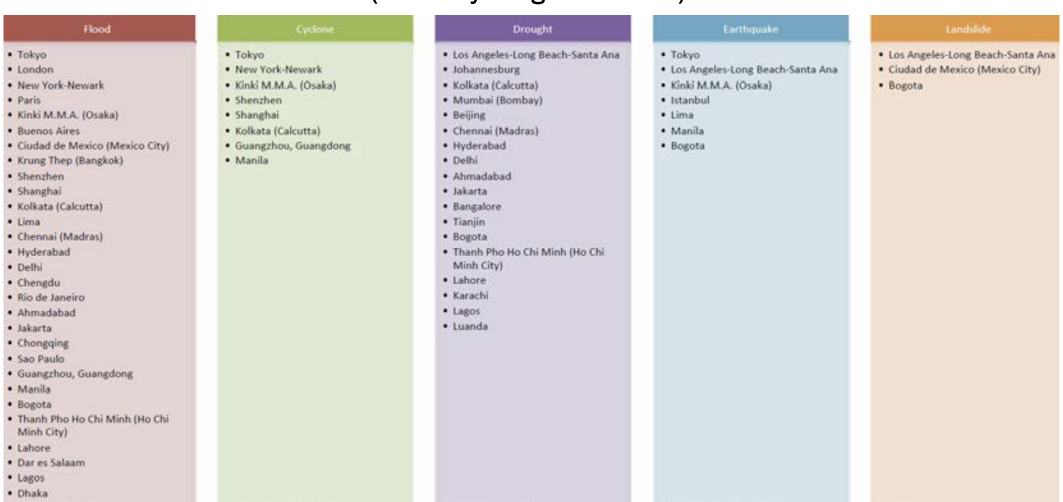


Figure 6. Megacities projected to have moderate to elevated risk for environmental hazard (sorted by integration score).



Note: Cities are listed in each category according to rank order typology score (highly integrated to loosely integrated).

The U.S. military must be prepared to engage in full spectrum operations in megacity and dense urban environments. It must also consider and prepare for the effects that the specific type of megacity (i.e., loosely, moderately or highly integrated) will have on varying orders of magnitude and

complexity of operations. Conducting operations in a highly integrated city such as Tokyo, London, or Paris, even with host nation cooperation, will still be challenging. However, those challenges are likely to differ significantly from those encountered while conducting similar operations in a loosely integrated megacity such as Dhaka, Lahore, or Lagos. Furthermore, as discussed in the next section, the scale and density of the megacity will likely challenge existing SOPs and doctrine that call for sea or remote basing instead of contingency basing due to logistical considerations of access, maneuverability, logistical supply, and the need to maintain security and communication.*

* TRADOC PAM 525 3-6, 3-4.c (HQ TRADOC 2010) discusses the role of sea basing and remote basing over contingency basing in circumstances where access is an issue.

3 Doctrinal Analysis

The significant likelihood of future U.S. military engagement in a megacity or dense urban environment necessitates a consideration of how well existing doctrine may address contingency basing in such an extreme environment. The intent of this work is not to present a thorough review of doctrine, but rather to highlight pertinent examples of areas where existing doctrine does not adequately address the conditions presented above in the Megacity Typology. Appendix B provides an extensive annotation of existing doctrine relevant to contingency basing that can serve to guide further research efforts in conducting such a thorough examination. This chapter is organized by the general doctrinal themes relating to contingency basing that emerged from the annotation process: background and assumptions, basics, site selection, logistics, and security.

3.1 Background/assumptions

The first matter that must be addressed is the recurring perception that U.S. military forces will not need to base inside a megacity, but that it can stage and base outside the megacity and project forces from a remote or “neighboring” area. This approach is based on the siege mentality supported by current urban operational doctrine (SSG 2014, p 4) that advocates for cordoning off the city to prevent anything or anyone from entering or leaving until military objectives are obtained. The effects of such an operation to the city would be tremendous in terms of flow, as the area would be shut out from the rest of the world. Depending on the market importance of the city, world economies could quickly experience adverse effects.

Various global indices that assess urban areas based on their business activity, economic status, culture, politics, information exchange, human capital, productivity, infrastructure, environment and quality of life metrics (UN-Habitat 2012, UN-Habitat 2013, Baker 2009, Brookings Institution 2015, Mercer LLC 2015, A.T. Kearney 2014) show that the highly integrated megacities (e.g., Tokyo, New York, Paris, London) tend to be ranked near the top of each list, as expected. Cities such as Istanbul, Turkey; Chengdu and Shanghai, China; Delhi, Mumbai and Kolkata, India; Jakarta, Indonesia; Buenos Aires, Argentina; and Sao Paolo, Brazil ranking relatively high on these lists due to their economic importance.

These indices also reflect the level of difficulty that would be involved with attempting to isolate any of these cities, or subparts within them, and the potential cascading impact on the world's economy that could result. Indeed, even the most loosely integrated megacities (e.g., Lahore, Karachi, Dhaka, Ahmadabad, Dar es Salaam) play significant roles in the world economy such that isolating them will have ramifications in far distant places. For example, Dhaka has a $19 billion/year garment industry that makes up 77% of its total merchandise export economy, and is second only to China in the world ready-made garment economy. Cordoning off any part of Dhaka and disrupting its garment industry would have rippling effects far beyond Bangladesh's borders (WTO 2015, Nordas 2004).

Social and economic considerations aside, such activities would require immense numbers of military personnel and materiel resources to effectively cordon a city. In addition to blocking roadways leading in and out of the city, air and ground assets would be needed to patrol and provide surveillance of open areas, while air and waterborne craft would be required to patrol rivers and surrounding ports. Another important consideration includes monitoring sewer and tunnel access that, depending on the city's infrastructure, could prove immensely taxing.

As noted, a megacity often includes surrounding areas (e.g., New York/Newark), which can equate to an enormous amount of space that must be constantly monitored. Although some of the megacities are quite compact, even the smallest (Ahmadabad, India at 350 km^2) still covers considerable space and has an extensive perimeter. Several of the Southeast Asian cities range from 2000 to 3000 km^2. Based on 2015 populations for Dhaka, Rio de Janeiro, Karachi, and Delhi, Table 4 lists the required troop levels needed based on doctrinal guidance for a "hasty defense," which calls for a 1 to 2.5 force ratio (SSG 2013, Table 2, p 6). Even to cordon off a 5-km square area within a dense urban megacity, such as the Old Dhaka sector within Dhaka, could require force levels upwards of 334,000 troops at a 1 to 2.5 ratio.

Table 4. Historical minimum planning ratios for hasty defense.

City	2015 Population	Required Troop Strength
Delhi	25,703,000	10,281,200
Dhaka	17,598,000	7,039,200
Karachi	16,618,000	6,647,200
Rio de Janeiro	12,902,000	5,160,800

Such staggering numbers call into question the feasibility and applicability of existing doctrine to the dense urban and megacity environment. The ability to successfully conduct such an operation would depend on the availability of resources—resources that the U.S. may not be able to provide in the current period of downsizing. For context, in fiscal year 2014, the total end strength for the Army was 1,066,600 soldiers (510,400 active duty, 202,000 Army Reserve, and 354,200 Army National Guard) (Heritage Foundation 2016), which does not meet the minimum 2.5:1 ratio requirements for most of the projected megacities. It is important to note that recommended troop levels for attacks call for 3:1 force ratio, which would be infeasible in any of these cities.

Complementary to this approach is the perception that the U.S. military can station troops outside the megacity and project operations from a removed base. There are a number of factors present in megacities and dense urban environments that make such operations difficult, if not infeasible. Troop movement is greatly inhibited by both built and human environments—the densities of people and structures can be such that movement is slowed, sometimes to a standstill, as roads become impassable. This creates an even greater security problem for soldiers attempting to reach their objective, as they may be forced to dismount from vehicles to cordon and search an area while they wait for the obstacle to be cleared, or sit in their stationary vehicles, which can be easily targeted by small arms, rocket, and Improvised Explosive Device (IED) attacks.

While doctrine recognizes that "[a]ir assault and airborne operations are crucial components of intratheater maneuver" (HQ TRADOC 2010, para 3-4b, p 27), the physical space may be such that current platforms are simply insufficient to accomplish this task. Air transportation may be hindered due to the lack of appropriate and available landing zones (LZs), with skyscrapers, shanty structures, and the often occurring "spider web" of power and communication lines providing additional obstacles that further complicate maneuverability.

Further complicating the distance and time it takes to travel from a remote base is that of medical evacuations (MEDEVAC). There are certain timeframes within which casualties need to make it to a higher echelon of care

(such as the “Golden Hour” and the “Platinum Ten”)* to have a greater chance of surviving their injuries. While not hard and fast rules, such time-frames are essential to improving mortality rates in battle.

In many megacities, regardless of integration level, doctrinal travel times will be difficult to achieve due to high levels of traffic congestion. A more highly integrated megacity may have better infrastructure than a more loosely integrated city to accommodate mounted movement, but population density often causes extensive travel delays and choking traffic (Figure 7). Indeed, according to the TomTom Worldwide Traffic Index (TomTom 2015), Istanbul, Mexico City, Rio de Janeiro and Moscow are the top four cities with the worst traffic, and 11 of the top 20 most congested cities in the world are on the list of megacities.

Figure 7. Traffic in Dhaka, Bangladesh (left) and in Tokyo, Japan (right).

Secondary to the perception that the U.S. military will not operate within a megacity is the belief that, if they do operate in such an environment, locating appropriate space within the megacity to set up contingency bases will not pose much trouble (the “we will take the space we need/we can relocate host populations as necessary” position). This position does not consider the impact this will have on the local population.

Furthermore, in a megacity and particularly in dense urban environments, the difficulty involved with “relocating” a neighborhood (or even a few city blocks) so that U.S. military forces can establish a presence is likely to be exponential compared to anything it has encountered in the past due to

* The “Golden Hour” is the first hour following a trauma injury, which is considered the most critical for successful emergency treatment. Likewise, the “Platinum Ten” refers to the period in which medical personnel arrive and assess the scene, initiate treatment, and transport injured personnel.

the density and magnitude in numbers of the population. Depending on the stability, infrastructure, governance and other conditions present in the area where U.S. forces want to set up, the resulting population displacement may overtax already fragile systems leading to unintended consequences that impact both the host nation and U.S. military personnel. In many of the 41 projected megacities, the readily “open” areas of the city that could feasibly contain a U.S. contingency base tend to be the location of government and other socially symbolic buildings (Figure 8), the occupation of which—as occurred in Baghdad—can have significant negative consequences because of the social connotations associated with such places in the minds of the local population.

Additionally, commercial and military air and sea ports are key enablers for intertheater maneuver. U.S. Army Training and Doctrine Command Pamphlet (TRADOC PAM) 525-3-6, states that:

> The goal is to move combat power from garrisons directly into action in a ready to fight configuration through military and commercial air ports and sea ports of embarkation,” and that intertheater airborne operations “should not require intermediate staging bases”(HQ TRADOC 2010, para 3-4a, pp 26-27)

While all of the projected megacities have major commercial airports, accessing those airports will not always be straightforward whether due to their disrepair, or their inability to accommodate the weight and size of U.S. military aircraft. An additional concern is the location of the airport and aircraft vulnerability to attack on takeoff and landing within a dense urban environment. Dhaka has both a military airport and an international airport; however, both are located in some of the densest areas of the city and are surrounded by slums (Figure 9). The difficulty of the task is well illustrated by another example, which occurred in September 2014, when India’s federal government asked Mumbai officials to clear the slums surrounding the Chhatrapati Shivaji International Airport due to increased concerns over terrorist attacks against airports in the region (Figure 10). The effort will involve removing 90,000 people—the population of a mid-sized American city—from roughly 309 acres of land (Kotoky 2014).

Figure 8. Military airport, government buildings, Dhaka, Bangladesh.

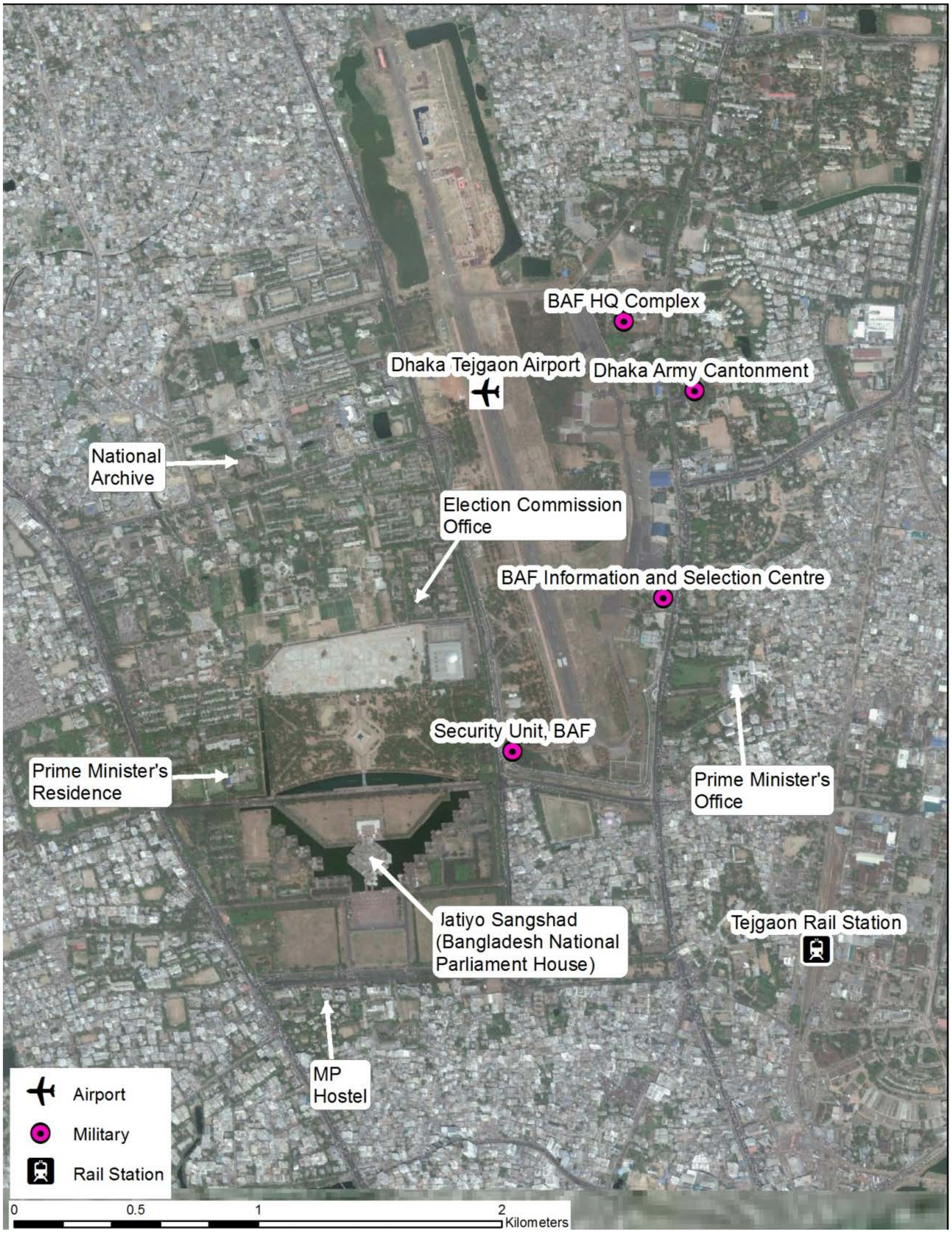


Figure 9. Dhaka, Bangladesh; Location of airports, ports, railroads and military installations.

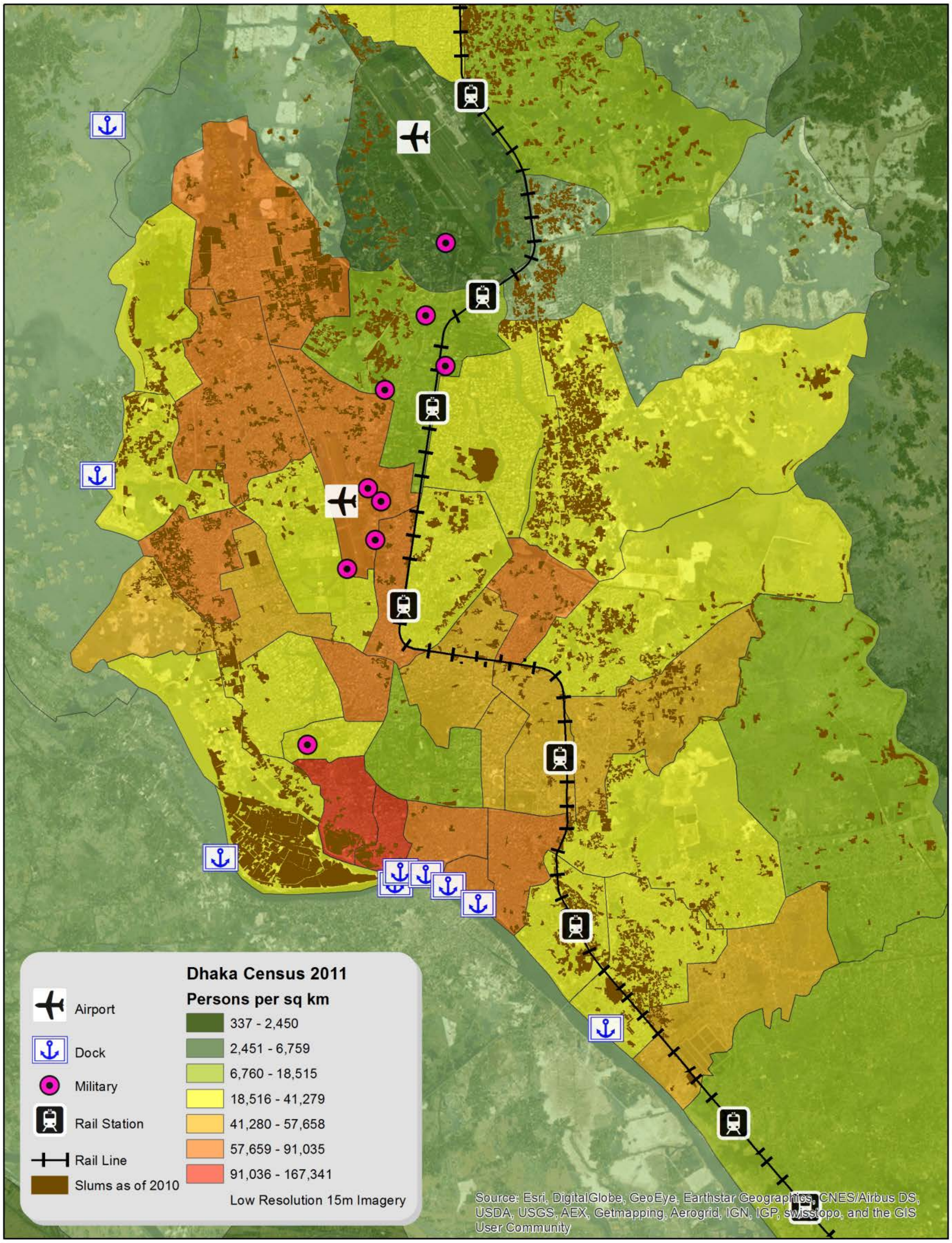


Figure 10. Slums surrounding the Mumbai International Airport.

Source: (left) Google Earth (2015); Kotoky (2015).

Port access is even further restricted than airport access. Ten of the countries containing the projected megacities have port facilities with an infrastructure quality rated at average or above; only 16 of the cities have a major port; the remaining cities are landlocked or have no access to a major body of water to support port facilities.

TRADOC PAM 525-3-6 discusses the role of sea basing as projection platforms to overcome anti-access issues within a theater of operations (HQ TRADOC 2010, para 304c, p 27). However, sea basing may become challenging when the nearest sea base can be as far as 1100 km from the megacity, as is the case with many of the Chinese megacities. Likewise, Moscow, Lahore, and some of the Indian megacities are nearly 1000 km from their nearest sea base. That is a substantial distance to overcome, particularly if engaging in Phase 2 operations.

3.2 Basics

The base camp life cycle, from strategy to planning, is largely influenced by the Combatant Commanders for the Area of Responsibility (AOR). TRADOC Pam 525-7-7 (HQ TRADOC 2009) notes that the lack of codified DoD or DA guidance on the detailed and conceptual aspects of base camp development has caused some subordinate organizations, “such as CENTCOM and U.S. Forces, Korea, to develop their own guidance documents and principles,” for example, CENTCOM Regulation 415-1 (“The Sand Book,” HQ USCENTCOM 2009) and U.S. Forces, Korea (USFK) Regulation 415-1 (HQ USFK 2004). With the absence of clearly defined scenarios for megacities and dense urban environments, as well as specific

doctrine for conducting operations within a megacity and/or dense urban environment, this indicates that combatant commanders and subordinate organizations are not currently prepared for establishing contingency basing in these extreme urban environments.

3.3 Site selection

The level of functionality, required services, and capabilities needed in a base camp will depend on the nature and projected length of the mission (see HQDA 2013, para 1-7 to 1-11, pp 1-2 to 1-3 for a more detailed discussion). This in turn will influence site selection. Doctrine (HQDA 2013) provides more specific guidance to commanders on various features within the operating environment to either collocate with and/or avoid, as well as mission variables, civil and environmental considerations, and mission objectives to keep in mind when selecting a base camp site. Doctrine also acknowledges that there may not be one best or optimum site selection that meets all criteria and that site selection may ultimately be a process of weighing the benefits and consequences associated with each of the suggested criteria. This will be particularly evident when attempting to site a base camp within a megacity or dense urban environment. For example, in Dhaka, the existing military cantonments are collocated with the Bangladesh National Parliament House, the Prime Minister's residence, and other government building complexes (Figure 8).

Depending on the scenario that might necessitate U.S. military forces to enter Dhaka, collocating with the government buildings may not support other mission objectives. There are apparently no military ports along the river in Dhaka, and even if there were, the congestion on the river would not meet requirements for standoff distance of other boats, post-USS Cole bombing (Figure 11). Furthermore, there is only one major railroad that runs through Dhaka, which supports the garment industry on the north side of the city, and which was built by the British (who left Bangladesh in 1947), and which does not appear to have been properly maintained since then (Figure 12).

Figure 11. Dhaka docks.

Figure 12. Dhaka railway tracks (left) and Gholanda Ghat Railway Station, Dhaka (right).

Doctrine does provide specific mission variables to consider in the contingency base site selection process, based on: Mission, Enemy, Terrain & Weather, Troops & Support available, Time and Civil Considerations/Mission, Enemy, Terrain, Troops & Time Available (METT-TC/METT-T); OAKOC[*]/KOCOA; and Areas, Structures, Capabilities, Organizations, People and Events (ASCOPE) variables (see Section B.3 in Appendix B for table listing these variables) (HQDA 2013).

If each mission variable is analyzed against the recommended site selection considerations as applied to a megacity and dense urban environment, the gaps in current doctrine as applied to this extreme environment become evident. For example, a common directive is to consider future base expansion when selecting a site. Finding sufficient land for the initial contingency base will be challenge enough (see the next Section on Logistics), but to find

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[*] Mnemonic for: **O**bservation and fields of fire/**A**venues of approach/**K**ey and decisive terrain/**O**bstacles/**C**over and concealment, formerly termed "KOCOA"

space with a buffer zone for potential expansion may simply not be possible depending on the initial size of the contingency base.

Ensuring access to sources of water, power and energy is its own challenge in many of the loosely to moderately integrated cities. In Dhaka, for example, many of the potential “open” places are located in low lying areas prone to flooding, or are currently construction zones. Furthermore, much of the city suffers from inadequate utility infrastructure that is easily overwhelmed by environmental conditions such as excessive heat or flooding (Figure 13). Degraded quality of local infrastructure that can barely keep up to the demand of existing residents is ill-suited to support or sustain the placement of a U.S. military contingency base. As stated above, the consideration given to the volume of displaced people caused by the base camp location must also be considered. In a megacity, and particularly in a dense urban environment, this will not be an inconsequential consideration.

Figure 13. Environmental conditions in Dhaka: Open sewers, flooding, air pollution, garbage.

3.4 Logistics

Locating a site for a contingency base requires enough land to house personnel, materiel, and necessary facilities. General base camp land use planning factors for a Heavy Brigade Combat Team-sized element, for example, call for between 1,780 and 2,185 total acres to meet requirements, roughly the size of Port Columbus International Airport (HQUSACE 2006, p E-4). In practice, contingency bases are often larger than this, e.g., Camp Diamondback in Mosul, Iraq had an area of roughly 2,200 to 2,300 acres.* Finding that amount of space in a megacity or dense urban environment may be difficult, though, with the availability of airports and other urban industrial areas, not impossible. The presence of such spaces in megacity or dense urban environments are of great importance in site selection, as such areas "facilitate the storage and movement of supplies ... provide readily available water, electricity, and other potentially useful urban resources and infrastructure" (HQDA 2006, p 10-4).

However, as evidenced in Figure 14, locating this amount of space may be problematic in an area such as Dhaka. Figure 14 shows three different sites of roughly the same square acreage as Camp Diamondback:

- Site A is located next to the International Airport in low density area, but is built on recent landfill over swamp land.
- Site B is located next to the military airport and the Parliament Building and other government facilities, but would also require displacing significant numbers of the local population—potentially upwards of 200,000 people (Figure 15) and may invoke negative symbolism (recall the Green Zone in Baghdad).
- Site C is located over the political and financial district and downtown area as well as where the elite of Dhaka reside, including the Presidential Palace; it also is not contiguous to an airport, would require significant population displacement at the edges—potentially upwards of 242,000 people—and is uncomfortably close to the slums of Old Dhaka and the security issues it would present (Figure 15).

* Area calculations for Camp Diamondback were determined using ESRI GIS ArcMap 10.1 and images from Google Earth.

Figure 14. Potential contingency base sites in Dhaka, aerial image.

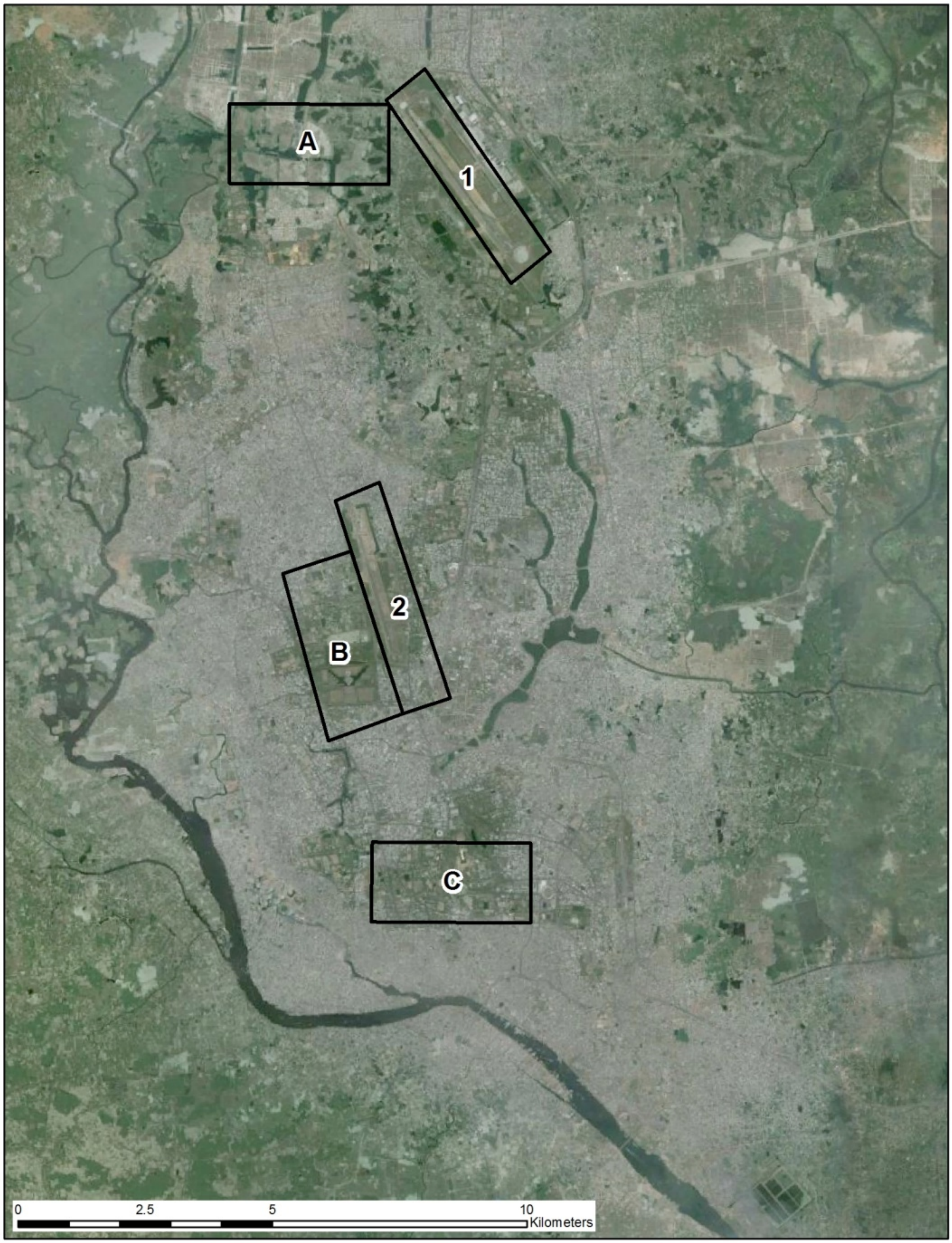
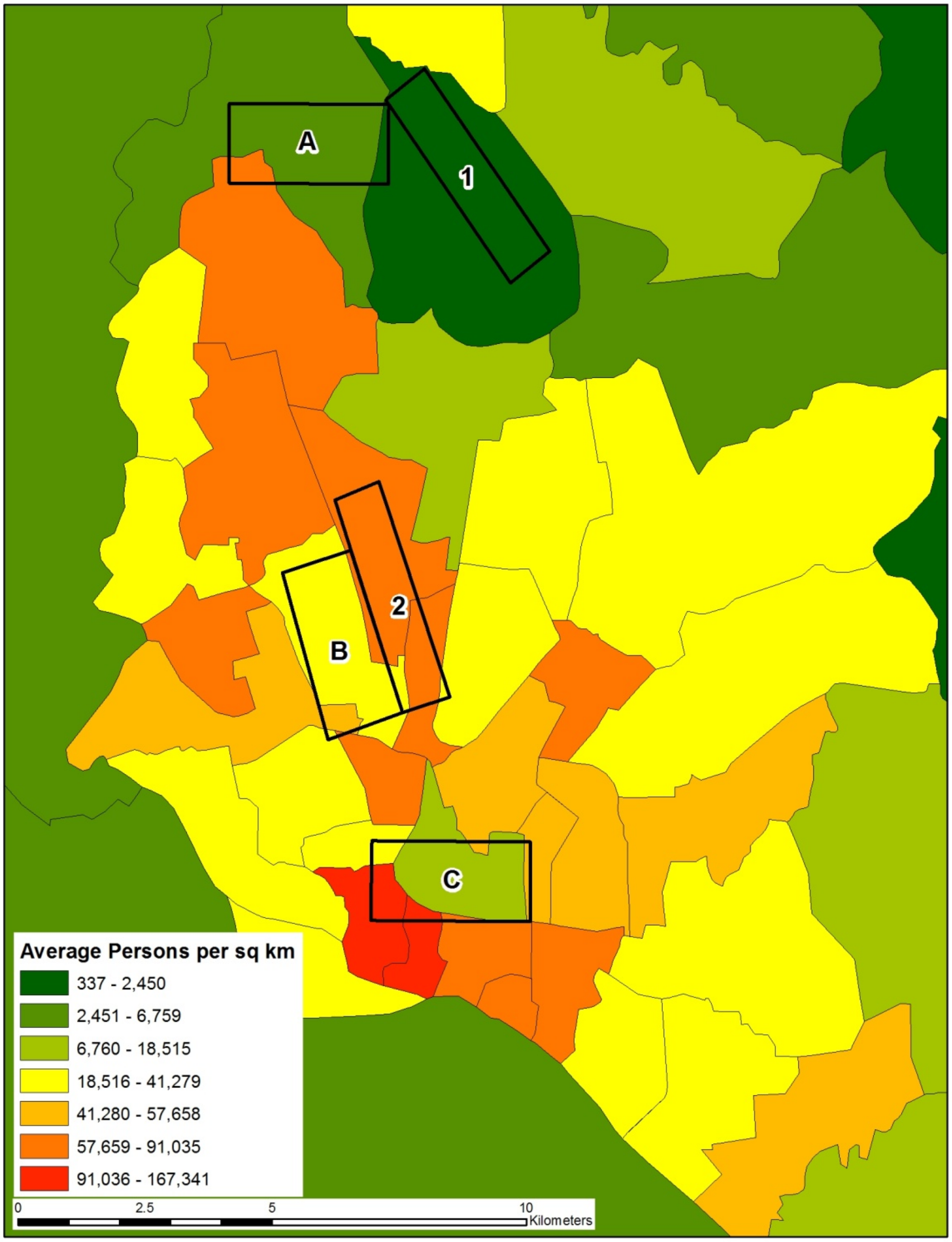


Figure 15. Potential contingency base sites with population density, Dhaka, Bangladesh.



Dhaka provides an excellent example of the tradeoffs that will need to be made in choosing a site for a contingency base within the megacity. Areas that provide the requisite space may come at a cost to security, access to adequate utilities or expose deployed soldiers to environmental hazards, and will likely require significant displacement of the local population (Figures 13 and 15). It is also important to note that loosely integrated cities may have poorly designed and inadequate infrastructure to support contingency basing in these environments. Moreover, U.S. use of host nation space and infrastructure will tax already limited resources, potentially destabilizing both social and physical infrastructure beyond the scope of operations.

3.5 Security

Base camp security is surely one of the most important aspects to consider, especially so in a megacity and dense urban environment. Considerations such as stand-off distance, clear zones, entry control points, nearby overwatch positions, lighting, and noise would be difficult to account for within such environments.

Standoff distances alone will be difficult to adequately account for in a megacity and dense urban environment, but other less site-specific considerations should also be taken into account. Proximity to indigenous neighborhoods should be of great concern, as attacks on contingency bases could easily produce civilian casualties due to the density of the urban space. Likewise, dislocating the indigenous population in less integrated areas, where poverty may already be of particular prominence, may result in criminal and extremist exploitation of the dislocated population. Locating a contingency base in or near these neighborhoods may exacerbate already strained conditions that may lead to grievances against U.S. military forces, particularly with respect to population displacement and disruption of daily patterns of life that may already be on the edge of survivability. For example, in some places in Dhaka, people walk 2 km round trip just to get water. If a contingency base were located between them and their water source, the daily increase in time and effort needed to simply to obtain basic necessities could result in second and third order negative effects. In a megacity and dense urban environment, human security, rather than physical security, should be closely monitored and further analyzed to mitigate more robust security issues.

4 Summary

4.1 Doctrinal gaps

There are currently numerous gaps in Army doctrine pertaining to situating a base camp in a megacity or dense urban environment. While it is understood that doctrine realistically provides little more than general guidance, it does not address the most fundamental aspect of base camps, that is, locating an appropriate site within such an extreme environment. Moreover, Army doctrine often notes that the "lack of codified DoD or DA guidance," necessitates organizations to develop their own guiding documents and principles (HQ TRADOC 2009, para 5-2.f, p 47).

Physical security remains a prominent problem not well addressed by doctrine, as does the general consensus on *how* and *where* a base camp would be situated within or even around a megacity and dense urban environment. As noted in an interview with Louis Dell'Orco (2015) (Chief of Operations, Readiness and Regulatory Division), the current thinking is that the Army would stay out of a megacity or dense urban environment altogether, electing instead to stay on the outskirts or in a remote area if pressed. Moreover, he stated there would be little reliance on published doctrine—save for SOPs such as the Sand Book—and more on the learned experience of having set up base camps elsewhere.

The lack of discussion in doctrine regarding the megacity and dense urban environment is clear evidence that doctrinal gaps exist. Part of this problem may stem from the historical lack of operational scenarios that would necessitate U.S. deployment into such areas. However, a more troubling concern is the general and accepted notion that inaction and non-engagement in these areas will suffice. If neglect of these very real possibilities in the megacity and dense urban environment continues, it could spell disaster for U.S. forces when environmental hazards or conflict inevitably strikes.

4.2 Suggested research

Several areas of research are needed to help address the gaps in existing doctrine and capabilities related to contingency basing within megacities and dense urban environments. One critical research area is in unclassified scenario development of U.S. military operations that may be required

within a megacity or dense urban environment. Developing a scenario based in a megacity or dense urban environment is required to not only overcome the prevailing assumption that the U.S. military will never operate in such an extreme environment, but also as previously noted, to create a base from which to develop basing strategies and plans, which are determined by mission and operational requirements. To truly determine where, how, and why a contingency base would be sited in a megacity or dense urban environment, viable scenarios must be produced. Such scenarios would support planning for contingencies that would necessitate U.S. military force projection into such areas, and would also provide tests of how current capabilities might address such contingencies to better explore strategic and doctrinal gaps and required capabilities.

Another area of necessary research is the development of a conceptual framework to determine the relevant physical, built, and sociocultural variables needed to assess the impacts of the base camp lifecycle on the operational environment. The base camp lifecycle refers to the site selection, design, construction, operation/management, and closure/transfer of a base camp. Such a study would provide an invaluable insight for planners and strategists in determining where and how a base camp may be sited, designed, constructed, etc. in a megacity and dense urban environment by overcoming existing gaps and shortfalls in both doctrine and analysis.

A third area of interest for research is the human domain. Research is needed to understand spatial and temporal patterns of daily life at the feature scale to enable high-fidelity modeling and forecasting of population movement, behavior and reaction within the dense urban and megacity environment. There will also be a need to rapidly assess and understand how and why different population subgroups are more or less resilient in the face of environmental and other disasters, along with the impact of such lack of resilience. Research is also needed to understand how, why, and where friction and violence between various subgroups occurs, and to determine its impact on the integration level of cities, e.g., to answer such questions as:

- What are the tipping points that may incite violence, protest or conflict between various groups and populations?
- How will the introduction of a U.S. military contingency base factor into that equation?

- Will it stabilize an area or exacerbate already strained resources, infrastructure, and polities to increase potential for violence, instability, and/or insurgency?

Research to develop models and simulations that leverage live data could offer the ability to efficiently assess and forecast the situation in, on, and around the contingency base.

Similarly, understanding resiliency within the megacity and dense urban environments will aid in the planning process for contingency basing. The existing research field commonly referred to as “new urbanism” suggests that urban areas may be more resilient and sustainable for the human population *because* of their density. The reasoning is that higher density areas have the ability to reduce carbon emissions, provide better access to health care, education and resources, and to potentially offer better standards of living through proximity to opportunities. However, real world conditions demonstrate that this is not always true and that different urban areas have varying levels of improvement related to density. Yet, surprisingly, it is not always the loosely integrated megacity conditions that are negatively correlated with resiliency and sustainability; the slum areas of many megacity and dense urban environments have historically demonstrated an incredible level of resiliency and sustainability in the face of extreme disasters. Dhaka, Rio de Janeiro, Karachi, Delhi all offer examples of resiliency under these conditions. This raises many research questions regarding the relationship between resiliency, sustainability, type of megacity (loosely-moderately-highly integrated), and whether patterns can be identified that may help U.S. military planners determine the best location for contingency bases to support operations.

Another research challenge that spans many tactical and operational concerns pertains to the cognitive overload that Soldiers and leaders face in urban environments—the Human Dimension (HQ TRADOC 2014b). Mitigating cognitive complexity could be an important factor in contingency base planning and operation as contingency bases seek to maintain effective security and provide opportunities for appropriate rest and recovery. As TRADOC Pam 525-3-7 notes with regard to the future operational environment, adversaries “may hide among the people in complex terrain to thwart the Army’s conventional combat overmatch. Adding to this com-

plexity is the continued urbanization and affordable access to social media," and further notes "Army leaders may become overwhelmed with information and face multiple dilemmas in shorter periods" (HQ TRADOC 2014b, para 2-1, p 7). With these challenges, which are especially present in a megacity environment, comes the importance of training and providing as many aids and solutions to create overmatch and opportunity where uncertainty is the greatest adversarial advantage.

Finally, perhaps the most pertinent research area that needs exploring is whether the U.S. military needs a new paradigm for contingency basing in the megacity and dense urban environment. The extreme environmental conditions inherent to the megacity and dense urban environment may force the U.S. military to rethink and adapt its current models and SOPs for basing. For example, except for combat outposts (COPs), current doctrine calls for concentrated contingency bases that accommodate entire units in one place. The reasoning behind this approach is to better ensure security, communications, logistics, command and control, and to be able to offer a higher quality of living within the contingency base by including recreational functions, which requires a minimum population.

However, in the megacity and dense urban environment, this reasoning may backfire. Instead of central basing, perhaps a new approach will focus on distributed basing involving footprints and contingencies that are smaller, but more agile and resilient to local conditions. Similarly, there may be a need for research to explore the concept of using existing vertical space (i.e., skyscrapers) for basing. Using this space has the potential to improve command and control, communications, visibility/overwatch, but will require methods to overcome the issues surrounding ingress/egress from the site, and new options for areal refit (creating add-on LZ's for vertical lift capability) that will allow multiple ways of accessing the base.

There are associated problems with using vertical spaces, however, which could make them impractical to use above certain floors/levels, as they cannot be fully protected, unless new technological means are developed to overcome the hazard. Alternatively, perhaps contingency basing will leverage existing underground spaces that might facilitate more uninhibited movement throughout the city, as well coverage and concealment. This will require research into how best to perpetuate broadband and communication signals underground, as well as ingress/egress issues. When

appropriately implemented, modeling, simulation, and wargaming offer significant potential to investigate such concepts and begin to explore the complexities involved.

Related areas of research may need to focus on development of new technologies and techniques that can compensate for reduced force strengths and/or overcome the challenges posed by the megacity and dense urban environments. Such research could address whether technological solutions can assist U.S. forces in cordoning off and controlling sections of a city without disrupting global economic processes. Traditional fortification methods that create significant standoff distances between the contingency base and the local population may be impractical in a megacity or dense urban environment, thus requiring technological solutions to compensate. It would be of great advantage to develop ways to leverage the conditions of the megacity to the advantage of U.S. forces.

Some of the above may seem futuristic; however, if a new paradigm for contingency basing in extreme urban environments is to be developed, this avenue of research may be required to best position the U.S. military for success in the megacity and dense urban environment. At a minimum, research must be conducted to properly prepare scenarios suited to the megacity and dense urban environment, and to better understand the human domain within these extreme environments, particularly as it relates to resiliency and sustainability both of the megacity and dense urban environment, and of the U.S. military's ability to successfully conduct operations within the constraints and opportunities of the complex urban environment system.

Acronyms and Abbreviations

Term	Definition
AFH	Air Force Handbook
AOR	Area of Responsibility
ASCOPE	Areas, Structures, Capabilities, Organizations, People and Events
AT/FP	Antiterrorism/Force Protection
ATP	Army Doctrine and Training Publication
BN	Billion
CEERD	U.S. Army Corps of Engineers, Engineer Research and Development Center
CENTCOM	U.S. Central Command
CERL	Construction Engineering Research Laboratory
COP	Combat Outpost
DA	Department of the Army
DoD	U.S. Department of Defense
DU	Dwelling Unit (DU)
EIU	Economist Intelligence Unit
EP	Engineer Pamphlet
ERDC	U.S. Army Engineer Research and Development Center
ERDC-CERL	Engineer Research and Development Center, Construction Engineering Research Laboratory
FAR	Floor Area Ratio
FOB	Forward Operating Base
GCI	Global Cities Index
GCRI	Global Conflict Risk Index
GDP	Gross Domestic Product
GSL	Geotechnical and Structures Laboratory
HADR	Humanitarian Assistance and Disaster Relief
IED	Improvised Explosive Device
LZ	Landing Zone
MEDEVAC	Medical Evacuation
METT	Mission, Enemy, Terrain and weather, Troops and support available
METT-T	Mission, Enemy, Terrain, Troops & Time Available (METT-T)
METT-TC	Mission, Enemy, Terrain & Weather, Troops & Support available, Time and Civil Considerations
OAKOC	Observation and Fields of fire, Avenues of approach, Key terrain, Obstacles and movement, Cover and concealment
PAM	Pamphlet
PPP	Purchasing Power Parity
QOL	Quality of Life
SEDAC	Socioeconomic Data and Applications Center

Term	Definition
SF	Standard Form
SOP	Standard Operating Procedure
SR	Special Report
SSG	Army Chief of Staff's Strategic Study Group
TR	Technical Report
TRADOC	U.S. Army Training and Doctrine Command
TTP	Tactics, Techniques, and Procedures
UFC	Unified Facilities Criteria
UK	United Kingdom
UN	United Nations
U.S.	United States
USAF	U.S. Air Force
USS	United States Ship

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Appendix A: Development of Prototype Megacities Typology Scores

This work developed an implementation of the megacity typology presented by the SSG (2014), which organizes megacities based on the level of integrated systems (Highly Integrated, Moderately Integrated, and Loosely Integrated) found in each megacity, as reflected by the level of formal versus informal systems, quality of infrastructure, and regulation of flow capacity for goods, resources, people, and information. Many data sources and variables were considered (Table A-1). The team selected these variables to implement the typology. The methodology and scoring presented here represents a prototype-quality level of implementation, prepared efficiently to quickly conduct an analysis of existing doctrine for contingency basing in dense urban and megacity environments. To produce a complete and high quality implementation of scoring for other purposes, the assessment should mitigate expeditious decisions made in the preparation of these scores. This would include thorough vetting of source material, statistically addressing variable types (e.g., rank-order data combined with ratio data) and covariance, mitigating use of country-level data in city-level analyses, and potentially developing a variable weighting scheme. The variables used and scoring prototype implemented did not require such actions, and clearly demonstrate the wide range of environments and challenges facing contingency basing in dense urban and megacity environments.

To transform the raw data Tables A-2 to A-5 into Z-scores for the taxonomy, each city's value was compared to the average value for the variable among all the projected megacities, and then divided by the standard deviation for the variable value among the projected megacities. This transformation is expressed by the formula:

(City Variable Value – Avg Variable Value) / Variable StDev = ZScore for City Variable

Thus, for each city and each variable, the formula indicates whether the city is average, and if it is not average, its directionality and magnitude of distance from average. Using the Z-scores allows exemplars of highly integrated city to set the high bar for certain variables and exemplars of loosely integrated cities to set the low bar, and then to use the variance to

determine what is likely to be seen as representative of moderately integrated megacities.

Once cities were assigned the Z-score values for each variable, the Z-score values were then averaged across each variable within a category. For example, flow capacity score was an average of the Z-score values for 2008 GDP, cell phone saturation, internet users, population change from 2010 to 2015, and economic performance from 2013 to 2014. These variables were not weighted in this preliminary implementation. The same approach was used to derive scores for infrastructure, and systems.

Once scores were derived for flow, infrastructure, and systems, these three scores were averaged to provide an overall assessment rating. These scores ranged from a minimum of -1.46 to a maximum of 1.58 and were still based on the Z-score values. These values were then transformed to a scale where 1 represented the lowest scoring cities, and 3 represented the highest scoring cities – mimicking the loosely integrated to highly integrated typology of the SSG report.

Table A-1. Sources selected for typology score calculation and descriptive statistics.

Typology Category	Subcategory	Directionality	Resolution	Data Element	Data Source	Source Data				
						Max	Min	Average	Median	Std Dev
Flow Capacity	Goods	Higher is better	City	2008 Est. GDP ($BN) PPP-Adjusted	Pricewaterhouse Coopers UK Economic Outlook, Nov. 2009	1,479.0	8.0	238.4	110.0	325.0
Flow Capacity	Information(a)	Higher is better	Country	Cell Phone Saturation 2013	ITU: Mobile-cellular telephone subscriptions per 100 inhabitants (2013)	162.5	41.8	96.3	88.7	28.6
Flow Capacity	Information(a)	Higher is better	Country	Internet Users (per 100 people) 2015	Quality of Government Institute, Jan. 2015 Standard Data	85.0	0.7	31.0	31.4	23.6
Flow Capacity	People	Lower is better	City	Average annual rate of population change (%) 2010-2015	UN Urban Agglomerations 2014	5.6	0.2	2.5	2.8	1.4
Flow Capacity	Resources	Lower is better	City	Economic Performance Rank 2013-2014	Global Metromonitor 2014	300.0	3.0	117.4	87.0	88.7
Infrastructure Quality	Overall	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Overall Infrastructure 2015	Quality of Government Institute, Jan. 2015	6.4	2.8	4.1	3.8	0.9
Infrastructure Quality	Air	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Air Transport 2015	Quality of Government Institute, Jan. 2015	6.2	3.0	4.6	4.5	0.8
Infrastructure Quality	Port	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Port 2015	Quality of Government Institute, Jan. 2015	5.8	2.6	4.2	4.0	0.8
Infrastructure Quality	Railroad	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Railroad 2015	Quality of Government Institute, Jan. 2015	6.6	1.6	3.7	4.4	1.4
Infrastructure Quality	Roads	Higher is better	Country	Quality of Infrastructure (Scale 1-7) - Roads 2015	Quality of Government Institute, Jan. 2015	6.5	2.3	4.0	3.5	1.1
Infrastructure Quality	Roads	Higher is better	City	Livability Assessment 2008	EIU 2008 Livability Survey	95.2	36.9	68.9	69.1	16.2
Systems	Governance	Higher is better	Country	Functioning Government 2015	Quality of Government Institute, Jan. 2015	12.0	1.0	6.2	7.0	3.3
Systems	Politics/Culture/Info /Human capital/Business	Higher is better	City	Global Cities Index Rankings 2010	AT Kearney Global Cities Index	6.2	0.3	2.2	1.7	1.6
Systems	QOL	Lower is better	City	Quality of Living (QOL) 2015	Mercer's 2015 City Rankings	223.0	27.0	132.6	136.0	50.6
Systems	Rule of Law	Higher is better	Country	Rule of Law 2015	Quality of Government Institute, Jan. 2015	15.0	-	7.1	7.0	4.2
Systems	Stability	Lower is better	Country	Fragile State Index 2015	Fund for Peace, 2015	109.7	33.4	73.2	76.4	19.5

Table A-2. Descriptive megacity statistics.

City (Urban Agglomeration)*	Country	2015 Pop	2030 Pop	Size (km²)	Pop. Density (people/km²) 2015	Pop. Density (people/km²) 2030
Ahmadabad	India	7,343	10,527	350	20,980	30,076
Al-Qahirah (Cairo)	Egypt	18,772	24,502	1,761	10,660	13,914
Bangalore	India	10,087	14,762	1,166	8,651	12,660
Beijing	China	20,384	27,706	3,820	5,336	7,253
Bogotá	Colombia	9,765	11,966	492	19,847	24,321
Buenos Aires	Argentina	15,180	16,956	2,681	5,662	6,325
Chengdu	China	7,556	10,104	1,541	4,903	6,557
Chennai (Madras)	India	9,890	13,921	971	10,186	14,337
Chongqing	China	13,332	17,380	932	14,304	18,648
Ciudad de México (Mexico City)	Mexico	20,999	23,865	2,072	10,134	11,518
Dar es Salaam	United Republic of Tanzania	5,116	10,760	570	8,975	18,876
Delhi	India	25,703	36,060	2,072	12,405	17,404
Dhaka	Bangladesh	17,598	27,374	360	48,884	76,038
Guangzhou, Guangdong	China	12,458	17,574	3,432	3,630	5,121
Hyderabad	India	8,944	12,774	1,230	7,271	10,385
Istanbul	Turkey	14,164	16,694	1,360	10,415	12,275
Jakarta	Indonesia	10,323	13,812	3,225	3,201	4,283
Johannesburg	South Africa	9,399	11,573	2,590	3,629	4,468
Karachi	Pakistan	16,618	24,838	945	17,585	26,283
Kinki M.M.A. (Osaka)	Japan	20,238	19,976	3,212	6,301	6,219
Kinshasa	Democratic Republic of the Congo	11,587	19,996	583	19,875	34,299
Kolkata (Calcutta)	India	14,865	19,092	1,204	12,346	15,858
Krung Thep (Bangkok)	Thailand	9,270	11,528	2,590	3,579	4,451
Lagos	Nigeria	13,123	24,239	907	14,468	26,725
Lahore	Pakistan	8,741	13,033	790	11,065	16,498
Lima	Peru	9,897	12,221	919	10,769	13,298

City (Urban Agglomeration)*	Country	2015 Pop	2030 Pop	Size (km²)	Pop. Density (people/km²) 2015	Pop. Density (people/km²) 2030
London	United Kingdom	10,313	11,467	1,738	5,934	6,598
Los Angeles-Long Beach-Santa Ana	United States of America	12,310	13,257	6,299	1,954	2,105
Luanda	Angola	5,506	10,429	894	6,159	11,665
Manila	Philippines	12,946	16,756	1,580	8,194	10,605
Moskva (Moscow)	Russian Federation	12,166	12,200	4,662	2,610	2,617
Mumbai (Bombay)	India	21,043	27,797	546	38,539	50,909
New York-Newark	United States of America	18,593	19,885	11,642	1,597	1,708
Paris	France	10,843	11,803	2,845	3,811	4,149
Rio de Janeiro	Brazil	12,902	14,174	2,020	6,387	7,017
São Paulo	Brazil	21,066	23,444	2,707	7,782	8,661
Shanghai	China	23,741	30,751	3,820	6,215	8,050
Shenzhen	China	10,749	12,673	1,748	6,150	7,250
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	7,298	10,200	1,489	4,901	6,850
Tianjin	China	11,210	14,655	2,007	5,586	7,302
Tokyo	Japan	38,001	37,190	8,547	4,446	4,351
Overall calculated:	Max	38,001.0	37,190.5	11,642.0	48,884.0	76,037.8
Overall calculated:	Min	5,115.7	10,104.4	350.0	1,597.1	1,708.1
Overall calculated:	Average	13,903.4	17,802.8	2,300.5	10,129.9	14,095.8
Overall calculated:	Median	12,309.5	14,762.1	1,738.0	7,271.2	10,385.0
Overall calculated:	StDev	6,364.9	7,198.7	2,219.9	9,214.0	14,058.5
Source: UN (2014)						

Table A-3. Flow capacity category city data.

City (Urban Agglomeration)§	Country	2008 Est. GDP ($BN) PPP-Adjusted	Cell Phone Saturation 2013	Internet Users (per 100 people)	2010-2015	Rank Economic Performance 2013-2014
Ahmadabad	India	49.0	70.8	7.5	3.4	**
Al-Qahirah (Cairo)	Egypt	145.0	121.5	31.4	2.1	82.0
Bangalore	India	69.0	70.8	7.5	4.0	87.0
Beijing	China	166.0	88.7	34.3	4.6	67.0
Bogotá	Colombia	100.0	104.1	36.5	2.8	88.0
Buenos Aires	Argentina	362.0	162.5	45.0	1.3	286.0
Chengdu	China	33.0	88.7	34.3	3.8	16.0
Chennai (Madras)	India	66.0	70.8	7.5	3.0	57.0
Chongqing	China	57.0	88.7	34.3	3.4	40.0
Ciudad de México (Mexico City)	Mexico	390.0	85.8	31.1	0.8	147.0
Dar es Salaam	United Republic of Tanzania	8.0	55.7	2.9	5.6	**
Delhi	India	167.0	70.8	7.5	3.2	18.0
Dhaka	Bangladesh	78.0	74.4	3.7	3.6	**
Guangzhou, Guangdong	China	143.0	88.7	34.3	5.2	77.0
Hyderabad	India	58.0	70.8	7.5	3.3	76.0
Istanbul	Turkey	182.0	93.0	39.8	2.2	3.0
Jakarta	Indonesia	92.0	125.4	10.9	1.4	34.0
Johannesburg	South Africa	110.0	145.6	24.0	3.2	173.0
Karachi	Pakistan	78.0	70.1	8.0	3.3	**
Kinki M.M.A. (Osaka)	Japan	417.0	117.6	78.2	0.8	247.0
Kinshasa	Democratic Republic of the Congo	17.0	41.8	0.7	4.2	**
Kolkata (Calcutta)	India	104.0	70.8	7.5	0.8	32.0
Krung Thep (Bangkok)	Thailand	119.0	140.1	22.4	2.4	300.0
Lagos	Nigeria	35.0	73.3	24.0	3.9	**
Lahore	Pakistan	40.0	70.1	8.0	3.1	**
Lima	Peru	109.0	98.1	34.8	2.0	48.0

City (Urban Agglomeration)§	Country	2008 Est. GDP ($BN) PPP-Adjusted	Cell Phone Saturation 2013	Internet Users (per 100 people)	2010-2015	Rank Economic Performance 2013-2014
London	United Kingdom	565.0	124.6	85.0	1.2	26.0
Los Angeles-Long Beach-Santa Ana	United States of America	792.0	95.5	74.0	0.2	148.0
Luanda	Angola	33.0	61.9	10.0	4.0	**
Manila	Philippines	149.0	104.5	25.0	1.7	139.0
Moskva (Moscow)	Russian Federation	321.0	152.8	43.0	1.2	218.0
Mumbai (Bombay)	India	209.0	70.8	7.5	1.6	52.0
New York-Newark	United States of America	1,406.0	95.5	74.0	0.2	176.0
Paris	France	564.0	98.5	77.3	0.7	260.0
Rio de Janeiro	Brazil	201.0	135.3	40.7	0.8	162.0
São Paulo	Brazil	388.0	135.3	40.7	1.4	284.0
Shanghai	China	233.0	88.7	34.3	3.4	92.0
Shenzhen	China	107*	88.7	34.3	1.0	64.0
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	58.0	130.9	30.7	3.3	23.0
Tianjin	China	74.0	88.7	34.3	3.4	152.0
Tokyo	Japan	1,479.0	117.7	78.2	0.6	201.0
Statistical Analyses:						
	Max	1,479.0	162.5	85.0	5.6	300.0
	Min	8.0	41.8	0.7	0.2	3.0
	Average	241.7	96.3	31.0	2.5	117.4
	Median	114.5	88.7	31.4	2.8	87.0
	StDev	328.4	28.6	23.6	1.4	88.7
§Notes:						
	Typology Category	Flow Capacity	Flow Capacity	Flow Capacity	Flow Capacity	Flow Capacity
	Subcategory	Goods	Information(a)	Information(a)	People	Resources
	Directionality	Higher is better	Higher is better	Higher is better	Lower is better	Lower is better
	Resolution	City	Country	Country	City	City

City (Urban Agglomeration)§	Country	2008 Est. GDP ($BN) PPP-Adjusted	Cell Phone Saturation 2013	Internet Users (per 100 people)	2010-2015	Rank Economic Performance 2013-2014
	Data Element	2008 Est. GDP ($BN) PPP-Adjusted	Cell Phone Saturation 2013	Internet Users (per 100 people) 2015	Average annual rate of population change (%) 2010-2015	Economic Performance Rank 2013-2014
	Data Source	Pricewaterhouse Coopers UK Economic Outlook, Nov. 2009	ITU: Mobile-cellular telephone subscriptions per 100 inhabitants (2013)	Quality of Government Institute, Jan. 2015 Standard Data	UN Urban Agglomerations 2014	Global Metromonitor 2014

**Missing value - Excluded from variable scores
*Shenzen missing GDP value, calculated average difference between all Chinese cities 2008-2014 values and then adjusted the Shenzen 2014 value to 2008.

Table A-4. Infrastructure category city data.

City (Urban Agglomeration)§	Country	Overall Infrastructure	Air Transport	Port	Railroad	Roads	EIU 2008 Liveability Survey
Ahmadabad	India	3.8	4.7	4.0	4.4	3.5	**
Al-Qahirah (Cairo)	Egypt	3.8	5.0	4.0	3.1	2.9	59.4
Bangalore	India	3.8	4.7	4.0	4.4	3.5	**
Beijing	China	4.3	4.5	4.5	4.6	4.4	75.2
Bogotá	Colombia	3.4	3.8	3.2	1.6	2.6	51.7
Buenos Aires	Argentina	3.4	3.5	3.7	1.7	3.1	83.6
Chengdu	China	4.3	4.5	4.5	4.6	4.4	**
Chennai (Madras)	India	3.8	4.7	4.0	4.4	3.5	**
Chongqing	China	4.3	4.5	4.5	4.6	4.4	**
Ciudad de México (Mexico City)	Mexico	4.4	4.8	4.3	2.8	4.5	65.2
Dar es Salaam	United Republic of Tanzania	3.1	3.5	3.3	2.3	3.2	**
Delhi	India	3.8	4.7	4.0	4.4	3.5	59.3
Dhaka	Bangladesh	2.8	3.5	3.3	2.5	2.8	36.9
Guangzhou, Guangdong	China	4.3	4.5	4.5	4.6	4.4	70.9
Hyderabad	India	3.8	4.7	4.0	4.4	3.5	**
Istanbul	Turkey	5.3	5.6	4.4	3.1	4.9	61.3
Jakarta	Indonesia	3.7	4.2	3.6	3.2	3.4	52.6

City (Urban Agglomeration)§	Country	Overall Infrastructure	Air Transport	Port	Railroad	Roads	EIU 2008 Liveability Survey
Johannesburg	South Africa	4.5	6.1	4.7	3.4	4.9	69.1
Karachi	Pakistan	3.4	4.3	4.4	2.6	3.9	41.4
Kinki M.M.A. (Osaka)	Japan	5.9	5.3	5.2	6.6	5.9	95.2
Kinshasa	Democratic Republic of the Congo	**	**	**	**	**	**
Kolkata (Calcutta)	India	3.8	4.7	4.0	4.4	3.5	**
Krung Thep (Bangkok)	Thailand	4.9	5.7	4.6	2.6	5.0	67.4
Lagos	Nigeria	3.2	4.0	3.6	1.9	2.8	39.7
Lahore	Pakistan	3.4	4.3	4.4	2.6	3.9	**
Lima	Peru	3.4	4.5	3.5	1.9	3.2	72.9
London	United Kingdom	5.6	6.0	5.8	5.0	5.6	90
Los Angeles-Long Beach-Santa Ana	United States of America	5.6	5.8	5.6	4.8	5.7	89.8
Luanda	Angola	**	**	**	**	**	**
Manila	Philippines	3.6	3.6	3.3	1.9	3.4	61.9
Moskva (Moscow)	Russian Federation	3.5	3.8	3.7	4.2	2.3	76.4
Mumbai (Bombay)	India	3.8	4.7	4.0	4.4	3.5	56
New York-Newark	United States of America	5.6	5.8	5.6	4.8	5.7	87.3
Paris	France	6.4	6.2	5.4	6.3	6.5	94.8
Rio de Janeiro	Brazil	3.4	3.0	2.6	1.8	2.7	69.1
São Paulo	Brazil	3.4	3.0	2.6	1.8	2.7	68.4
Shanghai	China	4.3	4.5	4.5	4.6	4.4	75.1
Shenzhen	China	4.3	4.5	4.5	4.6	4.4	73.4
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	3.2	4.1	3.5	2.6	2.7	53.2
Tianjin	China	4.3	4.5	4.5	4.6	4.4	76
Tokyo	Japan	5.9	5.3	5.2	6.6	5.9	94
Statistical Analyses:							
	Max	6.4	6.2	5.8	6.6	6.5	95.2
	Min	2.8	3.0	2.6	1.6	2.3	36.9
	Average	4.1	4.6	4.2	3.7	4.0	68.9

City (Urban Agglomeration)§	Country	Overall Infrastructure	Air Transport	Port	Railroad	Roads	EIU 2008 Liveability Survey
	Median	3.8	4.5	4.0	4.4	3.5	69.1
	StDev	0.9	0.8	0.8	1.4	1.1	16.2
§Notes:							
	Typology Category	Infrastructure Quality	Infrastructure Quality	Infrastructure Quality	Infrastructure Quality	Infrastructure Quality	Infrastructure Quality
	Subcategory	Overall	Air	Port	Railroad	Roads	Livability
	Directionality	Higher is better	Higher is better	Higher is better	Higher is better	Higher is better	Higher is better
	Resolution	Country	Country	Country	Country	Country	City
	Data Element	Quality of Infrastructure - Overall Infrastructure 2015	Quality of Infrastructure - Air Transport 2015	Quality of Infrastructure - Port 2015	Quality of Infrastructure - Railroad 2015	Quality of Infrastructure - Roads 2015	Livability Assessment 2008
	Data Source	Quality of Government Institute, Jan. 2015	Quality of Government Institute, Jan. 2015	Quality of Government Institute, Jan. 2015	Quality of Government Institute, Jan. 2015	Quality of Government Institute, Jan. 2015	EIU 2008 Livability Survey
**Missing value - Excluded from variable scores							

Table A-5. Systems category city data.

City (Urban Agglomeration)	Country	Functioning Government (Country) 2015	Global Cities Index (GCI)	QOL City Rankings	Rule of Law (Country) 2015	Fragile State Index 2015 (Country)
Ahmadabad	India	9.0	**	**	9.0	79.4
Al-Qahirah (Cairo)	Egypt	2.0	2.0	170.0	4.0	90.0
Bangalore	India	9.0	0.8	146.0	9.0	79.4
Beijing	China	2.0	3.1	118.0	2.0	76.4
Bogotá	Colombia	7.0	1.3	131.0	7.0	82.5
Buenos Aires	Argentina	6.0	2.7	91.0	10.0	47.6
Chengdu	China	2.0	**	133.0	2.0	76.4
Chennai (Madras)	India	9.0	**	151.0	9.0	79.4
Chongqing	China	2.0	0.3	142.0	2.0	76.4
Ciudad de México (Mexico City)	Mexico	7.0	2.4	126.0	6.0	71.8
Dar es Salaam	United Republic of Tanzania	7.0	**	198.0	10.0	80.8
Delhi	India	9.0	1.7	154.0	9.0	79.4
Dhaka	Bangladesh	6.0	0.6	211.0	7.0	91.8

City (Urban Agglomeration)	Country	Functioning Government (Country) 2015	Global Cities Index (GCI)	QOL City Rankings	Rule of Law (Country) 2015	Fragile State Index 2015 (Country)
Guangzhou, Guangdong	China	2.0	0.8	121.0	2.0	76.4
Hyderabad	India	9.0	**	138.0	9.0	79.4
Istanbul	Turkey	7.0	2.1	122.0	8.0	74.5
Jakarta	Indonesia	6.0	1.4	140.0	5.0	75.0
Johannesburg	South Africa	9.0	1.5	94.0	10.0	67.0
Karachi	Pakistan	5.0	0.7	202.0	4.0	102.9
Kinki M.M.A. (Osaka)	Japan	10.0	1.7	58.0	15.0	36.0
Kinshasa	Democratic Republic of the Congo	2.0	**	223.0	-	109.7
Kolkata (Calcutta)	India	9.0	0.6	160.0	9.0	79.4
Krung Thep (Bangkok)	Thailand	4.0	2.3	117.0	6.0	79.1
Lagos	Nigeria	6.0	0.7	211.0	5.0	102.4
Lahore	Pakistan	5.0	**	199.0	4.0	102.9
Lima	Peru	7.0	**	124.0	8.0	71.9
London	United Kingdom	12.0	5.9	40.0	15.0	33.4
Los Angeles-Long Beach-Santa Ana	United States of America	11.0	3.9	48.0	14.0	35.3
Luanda	Angola	1.0	**	200.0	4.0	88.1
Manila	Philippines	6.0	1.5	136.0	4.0	86.3
Moskva (Moscow)	Russian Federation	3.0	2.6	167.0	3.0	80.0
Mumbai (Bombay)	India	9.0	1.7	152.0	9.0	79.4
New York-Newark	United States of America	11.0	6.2	44.0	14.0	35.3
Paris	France	11.0	5.4	27.0	14.0	33.7
Rio de Janeiro	Brazil	7.0	1.6	119.0	9.0	62.6
São Paulo	Brazil	7.0	2.3	120.0	9.0	62.6
Shanghai	China	2.0	2.8	101.0	2.0	76.4
Shenzhen	China	2.0	0.6	139.0	2.0	76.4
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	1.0	0.7	153.0	4.0	72.4
Tianjin	China	2.0			2.0	76.4
Tokyo	Japan	10.0	5.4	44.0	15.0	36.0

City (Urban Agglomeration)	Country	Functioning Government (Country) 2015	Global Cities Index (GCI)	QOL City Rankings	Rule of Law (Country) 2015	Fragile State Index 2015 (Country)
Statistical Analyses:						
	Max	12.0	6.2	223.0	15.0	109.7
	Min	1.0	0.3	27.0	-	33.4
	Average	6.2	2.2	132.6	7.1	73.2
	Median	7.0	1.7	136.0	7.0	76.4
	StDev	3.3	1.6	50.6	4.2	19.5
§Notes:						
	Typology Category	Systems	Systems	Systems	Systems	Systems
	Subcategory	Governance	Politics/Culture/Info/Human capital/Business	QOL	Rule of Law	Stability
	Directionality	Higher is better	Higher is better	Lower is better	Higher is better	Lower is better
	Resolution	Country	City	City	Country	Country
	Data Element	Functioning Government 2015	Global Cities Index Rankings 2010	Quality of Living (QOL) 2015	Rule of Law 2015	Fragile State Index 2015
	Data Source	Quality of Government Institute, Jan. 2015	AT Kearney Global Cities Index	Mercer's 2015 City Rankings	Quality of Government Institute, Jan. 2015	Fund for Peace, 2015
**Missing value - Excluded from variable scores						

Table A-6. Megacities scores table sorted by city name, including variance.

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Ahmadabad	India	0.33	(0.08)	(0.78)	0.31	(0.18)	1.84
Al-Qahirah (Cairo)	Egypt	(0.75)	(0.35)	0.26	0.26	(0.28)	1.78
Bangalore	India	(0.02)	(0.08)	(0.63)	0.11	(0.24)	1.80
Beijing	China	(0.36)	0.31	(0.25)	0.13	(0.10)	1.89
Bogotá	Colombia	(0.15)	(1.17)	0.04	0.43	(0.43)	1.68
Buenos Aires	Argentina	0.62	(0.71)	0.44	0.52	0.12	2.04
Chengdu	China	(0.66)	0.29	(0.11)	0.23	(0.16)	1.86
Chennai (Madras)	India	0.16	(0.08)	(0.42)	0.08	(0.11)	1.89
Chongqing	China	(0.80)	0.29	(0.09)	0.31	(0.20)	1.83
Ciudad de México (Mexico City)	Mexico	0.07	0.04	0.19	0.01	0.10	2.03

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Dar es Salaam	United Republic of Tanzania	(0.18)	(1.08)	(1.38)	0.38	(0.88)	1.38
Delhi	India	0.06	(0.17)	(0.30)	0.03	(0.13)	1.87
Dhaka	Bangladesh	(0.71)	(1.33)	(0.80)	0.11	(0.95)	1.34
Guangzhou, Guangdong	China	(0.65)	0.27	(0.37)	0.22	(0.25)	1.79
Hyderabad	India	0.22	(0.08)	(0.51)	0.14	(0.12)	1.88
Istanbul	Turkey	0.12	0.43	0.32	0.03	0.29	2.15
Jakarta	Indonesia	(0.25)	(0.61)	0.28	0.20	(0.19)	1.84
Johannesburg	South Africa	0.44	0.59	(0.02)	0.10	0.34	2.18
Karachi	Pakistan	(0.98)	(0.57)	(0.74)	0.04	(0.76)	1.46
Kinki M.M.A. (Osaka)	Japan	1.22	1.63	0.60	0.27	1.15	2.72
Kinshasa	Democratic Republic of the Congo	(1.65)	NR	(1.27)	0.07	(1.46)	1.00
Kolkata (Calcutta)	India	(0.10)	(0.08)	(0.03)	0.00	(0.07)	1.91
Krung Thep (Bangkok)	Thailand	(0.17)	0.46	(0.24)	0.15	0.02	1.97
Lagos	Nigeria	(0.90)	(1.14)	(0.68)	0.05	(0.90)	1.37
Lahore	Pakistan	(0.98)	(0.34)	(0.73)	0.10	(0.68)	1.51
Lima	Peru	0.18	(0.63)	0.19	0.22	(0.09)	1.90
London	United Kingdom	1.96	1.54	1.24	0.13	1.58	3.00
Los Angeles-Long Beach-Santa Ana	United States of America	1.56	1.44	0.95	0.10	1.32	2.83
Luanda	Angola	(1.10)	NR	(0.95)	0.01	(1.02)	1.29
Manila	Philippines	(0.39)	(0.85)	0.01	0.19	(0.41)	1.69
Moskva (Moscow)	Russian Federation	(0.54)	(0.49)	0.50	0.35	(0.18)	1.84
Mumbai (Bombay)	India	0.06	(0.20)	(0.12)	0.02	(0.09)	1.90
New York-Newark	United States of America	1.86	1.41	1.27	0.09	1.51	2.95
Paris	France	1.83	1.99	0.54	0.63	1.45	2.92
Rio de Janeiro	Brazil	0.23	(1.23)	0.47	0.85	(0.18)	1.84
São Paulo	Brazil	0.32	(1.24)	0.22	0.76	(0.23)	1.81

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Shanghai	China	(0.33)	0.31	(0.10)	0.10	(0.04)	1.93
Shenzhen	China	(0.74)	0.29	0.38	0.39	(0.02)	1.94
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	(0.72)	(0.92)	0.23	0.38	(0.47)	1.65
Tianjin	China	(0.88)	0.32	(0.33)	0.36	(0.30)	1.76
Tokyo	Japan	1.74	1.62	1.39	0.03	1.58	3.00

Table A-7. Megacities scores table sorted by 1-3 score; 1 is loosely integrated, 3 is highly integrated.

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Kinshasa	Democratic Republic of the Congo	(1.65)	NR	(1.27)	0.07	(1.46)	1.00
Luanda	Angola	(1.10)	NR	(0.95)	0.01	(1.02)	1.29
Dhaka	Bangladesh	(0.71)	(1.33)	(0.80)	0.11	(0.95)	1.34
Lagos	Nigeria	(0.90)	(1.14)	(0.68)	0.05	(0.90)	1.37
Dar es Salaam	United Republic of Tanzania	(0.18)	(1.08)	(1.38)	0.38	(0.88)	1.38
Karachi	Pakistan	(0.98)	(0.57)	(0.74)	0.04	(0.76)	1.46
Lahore	Pakistan	(0.98)	(0.34)	(0.73)	0.10	(0.68)	1.51
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	(0.72)	(0.92)	0.23	0.38	(0.47)	1.65
Bogotá	Colombia	(0.15)	(1.17)	0.04	0.43	(0.43)	1.68
Manila	Philippines	(0.39)	(0.85)	0.01	0.19	(0.41)	1.69
Tianjin	China	(0.88)	0.32	(0.33)	0.36	(0.30)	1.76
Al-Qahirah (Cairo)	Egypt	(0.75)	(0.35)	0.26	0.26	(0.28)	1.78
Guangzhou, Guangdong	China	(0.65)	0.27	(0.37)	0.22	(0.25)	1.79
Bangalore	India	(0.02)	(0.08)	(0.63)	0.11	(0.24)	1.80
São Paulo	Brazil	0.32	(1.24)	0.22	0.76	(0.23)	1.81
Chongqing	China	(0.80)	0.29	(0.09)	0.31	(0.20)	1.83
Ahmadabad	India	0.33	(0.08)	(0.78)	0.31	(0.18)	1.84
Jakarta	Indonesia	(0.25)	(0.61)	0.28	0.20	(0.19)	1.84
Moskva (Moscow)	Russian Federation	(0.54)	(0.49)	0.50	0.35	(0.18)	1.84

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Rio de Janeiro	Brazil	0.23	(1.23)	0.47	0.85	(0.18)	1.84
Chengdu	China	(0.66)	0.29	(0.11)	0.23	(0.16)	1.86
Delhi	India	0.06	(0.17)	(0.30)	0.03	(0.13)	1.87
Hyderabad	India	0.22	(0.08)	(0.51)	0.14	(0.12)	1.88
Beijing	China	(0.36)	0.31	(0.25)	0.13	(0.10)	1.89
Chennai (Madras)	India	0.16	(0.08)	(0.42)	0.08	(0.11)	1.89
Lima	Peru	0.18	(0.63)	0.19	0.22	(0.09)	1.90
Mumbai (Bombay)	India	0.06	(0.20)	(0.12)	0.02	(0.09)	1.90
Kolkata (Calcutta)	India	(0.10)	(0.08)	(0.03)	0.00	(0.07)	1.91
Shanghai	China	(0.33)	0.31	(0.10)	0.10	(0.04)	1.93
Shenzhen	China	(0.74)	0.29	0.38	0.39	(0.02)	1.94
Krung Thep (Bangkok)	Thailand	(0.17)	0.46	(0.24)	0.15	0.02	1.97
Ciudad de México (Mexico City)	Mexico	0.07	0.04	0.19	0.01	0.10	2.03
Buenos Aires	Argentina	0.62	(0.71)	0.44	0.52	0.12	2.04
Istanbul	Turkey	0.12	0.43	0.32	0.03	0.29	2.15
Johannesburg	South Africa	0.44	0.59	(0.02)	0.10	0.34	2.18
Kinki M.M.A. (Osaka)	Japan	1.22	1.63	0.60	0.27	1.15	2.72
Los Angeles-Long Beach-Santa Ana	United States of America	1.56	1.44	0.95	0.10	1.32	2.83
Paris	France	1.83	1.99	0.54	0.63	1.45	2.92
New York-Newark	United States of America	1.86	1.41	1.27	0.09	1.51	2.95
London	United Kingdom	1.96	1.54	1.24	0.13	1.58	3.00
Tokyo	Japan	1.74	1.62	1.39	0.03	1.58	3.00

Table A-8. Megacities scores table sorted by variance of Z-Scores.

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Kolkata (Calcutta)	India	(0.10)	(0.08)	(0.03)	0.00	(0.07)	1.91
Luanda	Angola	(1.10)	NR	(0.95)	0.01	(1.02)	1.29
Ciudad de México (Mexico City)	Mexico	0.07	0.04	0.19	0.01	0.10	2.03
Mumbai (Bombay)	India	0.06	(0.20)	(0.12)	0.02	(0.09)	1.90
Delhi	India	0.06	(0.17)	(0.30)	0.03	(0.13)	1.87
Istanbul	Turkey	0.12	0.43	0.32	0.03	0.29	2.15
Tokyo	Japan	1.74	1.62	1.39	0.03	1.58	3.00
Karachi	Pakistan	(0.98)	(0.57)	(0.74)	0.04	(0.76)	1.46
Lagos	Nigeria	(0.90)	(1.14)	(0.68)	0.05	(0.90)	1.37
Kinshasa	Democratic Republic of the Congo	(1.65)	NR	(1.27)	0.07	(1.46)	1.00
Chennai (Madras)	India	0.16	(0.08)	(0.42)	0.08	(0.11)	1.89
New York-Newark	United States of America	1.86	1.41	1.27	0.09	1.51	2.95
Lahore	Pakistan	(0.98)	(0.34)	(0.73)	0.10	(0.68)	1.51
Shanghai	China	(0.33)	0.31	(0.10)	0.10	(0.04)	1.93
Johannesburg	South Africa	0.44	0.59	(0.02)	0.10	0.34	2.18
Los Angeles-Long Beach-Santa Ana	United States of America	1.56	1.44	0.95	0.10	1.32	2.83
Dhaka	Bangladesh	(0.71)	(1.33)	(0.80)	0.11	(0.95)	1.34
Bangalore	India	(0.02)	(0.08)	(0.63)	0.11	(0.24)	1.80
Beijing	China	(0.36)	0.31	(0.25)	0.13	(0.10)	1.89
London	United Kingdom	1.96	1.54	1.24	0.13	1.58	3.00
Hyderabad	India	0.22	(0.08)	(0.51)	0.14	(0.12)	1.88
Krung Thep (Bangkok)	Thailand	(0.17)	0.46	(0.24)	0.15	0.02	1.97
Manila	Philippines	(0.39)	(0.85)	0.01	0.19	(0.41)	1.69
Jakarta	Indonesia	(0.25)	(0.61)	0.28	0.20	(0.19)	1.84
Guangzhou, Guangdong	China	(0.65)	0.27	(0.37)	0.22	(0.25)	1.79
Lima	Peru	0.18	(0.63)	0.19	0.22	(0.09)	1.90
Chengdu	China	(0.66)	0.29	(0.11)	0.23	(0.16)	1.86
Al-Qahirah (Cairo)	Egypt	(0.75)	(0.35)	0.26	0.26	(0.28)	1.78
Kinki M.M.A. (Osaka)	Japan	1.22	1.63	0.60	0.27	1.15	2.72

City (Urban Agglomeration)	Country	Systems Z-Score	Infrastructure Z-Score	Flow Z-Score	Overall Variance of Z-Scores	Overall Z-Score	1-3 Score Transform
Chongqing	China	(0.80)	0.29	(0.09)	0.31	(0.20)	1.83
Ahmadabad	India	0.33	(0.08)	(0.78)	0.31	(0.18)	1.84
Moskva (Moscow)	Russian Federation	(0.54)	(0.49)	0.50	0.35	(0.18)	1.84
Tianjin	China	(0.88)	0.32	(0.33)	0.36	(0.30)	1.76
Dar es Salaam	United Republic of Tanzania	(0.18)	(1.08)	(1.38)	0.38	(0.88)	1.38
Thành Pho Ho Chí Minh (Ho Chi Minh City)	Viet Nam	(0.72)	(0.92)	0.23	0.38	(0.47)	1.65
Shenzhen	China	(0.74)	0.29	0.38	0.39	(0.02)	1.94
Bogotá	Colombia	(0.15)	(1.17)	0.04	0.43	(0.43)	1.68
Buenos Aires	Argentina	0.62	(0.71)	0.44	0.52	0.12	2.04
Paris	France	1.83	1.99	0.54	0.63	1.45	2.92
São Paulo	Brazil	0.32	(1.24)	0.22	0.76	(0.23)	1.81
Rio de Janeiro	Brazil	0.23	(1.23)	0.47	0.85	(0.18)	1.84

Appendix B: Annotated Doctrinal Review

Contents

B.1 Background/assumptions

B.1.1 TRADOC Pam 525-3-0, The U.S. Army Capstone Concept

1-2.a.(5): ASSUMPTIONS: "Army forces will deploy from the continental U.S. or forward bases and operate in areas where access is denied and cyberspace capabilities are degraded."

2-1c: "Rebalancing the ***focus on the Asia-Pacific and Middle East regions***. While the U.S. military continues to protect U.S. national security interests across the globe, it must focus on protecting those interests where they are in most jeopardy. The ***greatest potential threats to those interests lie in Asia and the Middle East***, and the U.S. Army's role extends to both. The Army cannot focus on just one without creating unacceptable risk in the other. The Army ***must realign its forces and adjust priorities as focus shifts***, while seeking to maintain a global equilibrium."

2-1d: "A wide variety of threats. The U.S. will also confront a diverse group of ***threats*** that may ***include state and non-state actors, paramilitary forces, proxies, insurgents, criminal organizations, terrorists, and technologically-empowered individuals***. These threats will ***oppose American interests*** using adaptive forces that operate in a ***decentralized manner to frustrate America's traditional advantages in firepower and mobility***...Sophisticated state and non-state actors will conduct operations by themselves or through proxies to ***entangle the U.S. in protracted conflicts, test American resolve, or deter action by presenting military situations that may require high levels of casualties and perseverance to solve***. Additionally, opportunists will emerge from the environment and exploit the chaos of conflict to pursue a variety of objectives, often changing the character of that conflict over time."

2-1f: A2AD

2-1g: WMD proliferation

3-5.b.(2): "...***Reducing reliance on intermediate staging bases, ports, and airfields will better enable an expeditionary***

Army to respond rapidly and attack simultaneously throughout the depth and breadth of a joint operations area (JOA) while diminishing enemy anti-access and area denial capabilities." (particularly WRT RAF, etc.)

3-5.b.(3): "...The Secretary of Defense, in coordination with combatant commanders and key interagency partners, determines the integrated U.S. posture and basing strategy, which aligns forces and bases to deter conflict, respond rapidly to contingency requirements, and enhance U.S. strategic flexibility for force deployment."

B.1.2 TRADOC Pam 525-3-1, The U.S. Army Operating Concept: Win in a Complex World

1-5.a.(3): "Army forces remain engaged overseas in areas vital to U.S. security interests, but a larger percentage of the force will be based in the continental United States." [thus, basing will be key in TO]

2-3.b.(5): "***Urban areas become safe havens and support bases for terrorists, insurgents, or criminal organizations***. Urban areas are potential scenes for mass atrocities. Enemies may use cities as launching platforms for long-range missiles that threaten allied as well as U.S. populations. ***Because urban environments degrade the ability to target threats with precision, joint operations will require land forces capable of operating in congested and restricted urban terrain*** (to include subsurface, surface, supersurface) to defeat those threats ..."

B.1.3 TRADOC Pam 525-3-6, The U.S. Army Functional Concept for Movement and Maneuver

3-4a.: "Intertheater maneuver is maneuver over extended distances to enable the force to gain positional advantage over an enemy. It includes force projection tasks including deployment to intermediate staging bases and entry operations, both unopposed and forcible. The goal is to move combat power from garrisons directly into action in a ready to fight configuration through military

and commercial air ports and sea ports of embarkation. This produces strategic and operational surprise and limits antiaccess efforts of enemy forces. For example, intertheater airborne operations should not require intermediate staging bases. The development of capabilities, such as future theater lift and sea bases, is required for efficient and timely intertheater operational maneuver for heavier forces."

3-4b.: "Intratheater maneuver is maneuver within a theater to achieve a positional advantage over an enemy. The future force may ***conduct intratheater maneuver to dominate an AO by seizing key terrain, securing populations, or destroying enemy forces and capabilities in depth.*** Air assault and airborne operations are crucial components of intratheater maneuver. The force must have platforms with sufficient speed, range, lift capacity, and the ability to land at unimproved, degraded, or less than optimal locations to enable maneuver and mitigate risks posed by enemy antiaccess and area-denial operations."

3-4c.: "The future maneuver force remains campaign quality and is supported by seabasing and ship-to-shore capabilities. An afloat forward staging base affords a forcible entry capability by seabasing a BCT and provides the capability to conduct shipboard operations from or through the joint sea base for early entry, personnel movement, or sustainment operations. This includes the ability to conduct vertical maneuver of forces from specifically configured sea-based platforms to counter antiaccess. Joint airlift platforms are capable of shipboard operations to project combat power directly ashore while limiting the effects of antiaccess efforts. Seabasing allows Army aviation to maintain a projection platform that can be globally deployed while limiting the effects of antiaccess efforts within a theater of operations. Army aviation platforms will possess the capabilities required for shipboard operations."

3-4d.: "Improved vertical lift over current systems provides intratheater aerial extension to joint deployment and employment. This capability provides continuous, precise, assured provisioning of deployed forces in virtually any environment, guaranteeing their

ability to generate, maintain, and employ combat power throughout the campaign."

3-5c.: "When peacetime efforts fail, maneuver forces participate in joint entry operations. Maneuver forces move into a required operational area by air, land, or sea port, or if opposed, by seizing a lodgment to enable the operations of follow-on forces or to conduct a specific operation. Since advanced air and sealift capabilities that permit strategic or intertheater movement of unimproved ports of debarkation are not fielded in the quantities required in the 2016-2028 timeframe, the future Army forces will use access to nearby ports (ports where access is granted) and intermediate staging bases or sea bases to commence entry operations."

B.2 Basics

B.2.1 ADRP 4-0, Sustainment

2-5: "...Setting the theater includes whole-of-government initiatives such as bilateral or multilateral agreements to allow U.S. forces to have access to ports, terminals, airfields, and bases within the area of responsibility (AOR) to support future military contingency operations."

2-6: "...The theater sustainment command is responsible for theater opening and setting the theater."

2-43: IMCOM support: "...provides capabilities to ***operate and manage bases*** in support of Army and Joint Force commanders."

2-95: under Acquisition Cross-Servicing Agreement (ACSA [Title 10 USC, sections 2341 and 2342]); "Under these agreements, common support may include ***food, billeting, ... base operations, storage services, use of facilities... and port services***."

3-52: "*Theater opening* (TO) is the ability to establish and operate ports of debarkation (air, sea, and rail) to establish a distribution system and sustainment bases, and to facilitate port throughput for the reception, staging, onward movement and integration of forces within a theater of operations (ADP 4-0). Preparing for TO operations requires unity of effort among the various commands

and a seamless strategic-to-tactical interface. It is a complex joint process involving the GCC and strategic and joint partners such as USTRANSCOM and DLA. TO functions set the conditions for effective support and lay the groundwork for subsequent expansion of the theater distribution system."

3-53: "When given the mission to conduct TO, a sustainment brigade, designated a sustainment brigade (TO), and a mix of functional battalions and multi-functional CSSBs are assigned based on mission requirements. The sustainment brigade HQ staff may be augmented with a Transportation Theater Opening Element to assist in managing the TO mission. The augmentation element provides the sustainment brigade with additional manpower and expertise to command and control TO functions, to conduct transportation planning, and provide additional staff management capability for oversight of RSOI operations, port operations, node and mode management, intermodal operations, and movement control. ***The sustainment brigade will participate in assessing and acquiring available HN [host nation] infrastructure capabilities and contracted support and coordinating with military engineers for general engineering support (FMI 4-93.2 and ATTP 4-0.1)***"

B.3 Site selection

B.3.1 Gen. Considerations

B.3.1.1 ADRP 5-0, The Operations Process

3-10: "During preparation, sustainment planners at all levels take action to optimize means (force structure and resources) for supporting the commander's plan. These actions include, but are not limited to, ***identifying and preparing bases, host-nation infrastructure and capabilities, contract support requirements, and lines of communications***."

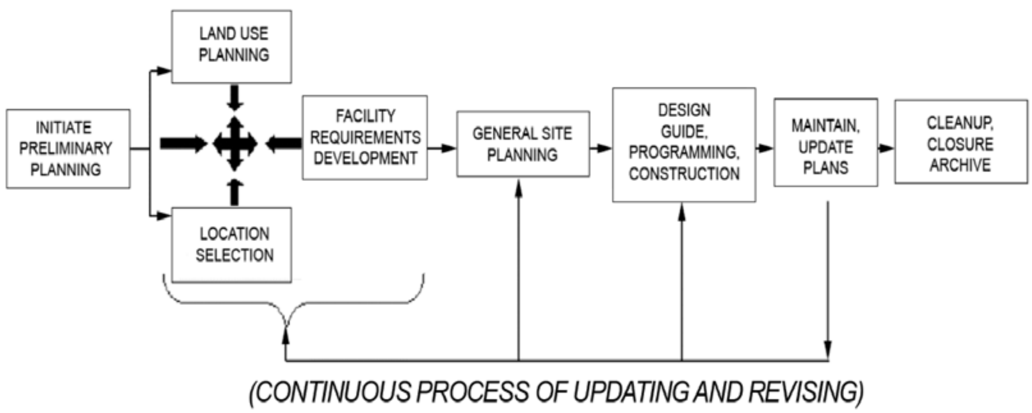
B.3.1.2 Engineer Pamphlet (EP) 1105-3-1, Base Camp Development in the Theater of Operations

2-2. "The BCDP [Base Camp Development Planning] process consists of several, not always linear, steps. This process relates to the

master planning and military decision-making processes… the steps are:

- Initiate preliminary planning
- Location selection
- Land use planning
- Facility requirements development
- General site planning
- Design guide, programming, and construction
- Maintain and update plans
- Cleanup, closure, and archive."

Figure B-1. The base camp development planning process.



2-2.b.(5): "*General site planning*. Once preliminary site planning has been completed, general site planning further refines the product. General site planning takes the initial land use plan, facility requirements, and coordination with customer requirements, and completes the base camp design. It includes individual building layouts shown within the pre-identified land uses. In this step, final decisions with regard to facility types, standards, construction, and the final location of specific structures and facilities are made (see Chapter 9)."

4-5.b.(3): "*Doctrine*. Various references impact base camp operations. These include FMs, service regulations, theater-specific base camp guidance (such as the Sand Book), and other documents including status-of-forces agreements (SOFAs) and DoD Publication 4715.5-G. JP 3-34 provides the basic doctrine that establishes base camp standards and allowances. Planners should be aware of the rel-

evant documents that govern base camp location selection, construction, operations, sustainment, and closure. The Judge Advocate General (JAG) of the various services can provide information on many legal issues associated with base camps. These legal issues include liabilities, real estate leasing, contracting, purchasing, and such.

6-3.d.(2): [6-3.d. discusses conducting environmental analysis broadly] "Some of the environmental attributes and factors that the planning team should look for and analyze include—

- Safety and antiterrorism/force protection (AT/FP) clearance zones.
- Restricted areas.
- Airfield clearance zones.
- Noise.
- Topography.
- Floodplains.
- Wetlands.
- Soils.
- Threatened or endangered species.
- Contaminated sites, landfills, and hazardous/toxic waste.
- Water and wastewater treatment facilities.
- Surface water and groundwater (aquifer recharge areas).
- Electromagnetic transmission zones.
- Historical, archeological, cultural, and religious sites.
- Wind patterns and air pollution.
- Underground storage tank sites.
- Adjacent landowners and occupants.
- Open space/buffer areas.
- Seasonal constraints/restrictions.

B.3.2 Evaluation

B.3.2.1 EP 1105-3-1, Base Camp Development in the Theater of Operations

3-2.c.: "*Course of action development or develop goals and objectives*. The remaining steps of the MDMP or the master planning process are most commonly used to support the BCDP process steps of site selection, land use planning, general site planning, and cleanup and closure. Using the information gained from the mission analysis, the planning team should begin to develop

courses of action (COAs). In optimal situations, the team should strive to develop three COAs with the screening criteria of feasible, acceptable, suitable, and distinguishable. During every step of the BCDP process, the planner must continue to request and develop information about the projected site. A description of the screening criteria is as follows:

- Feasible. A COA is considered feasible if it allows the team to accomplish the mission within the available time, space, and resources available.
- Acceptable. A COA is considered acceptable if it justifies the cost in resources.
- Suitable. A COA is considered suitable if it will accomplish the mission and comply with the customer's intent/guidance.
- Distinguishable. A COA is considered to be distinguishable if it differs from the others."

3-2.d.: "*Course of action analysis/comparison or develop/evaluate alternatives*. After the planning team has developed the COAs, they must analyze and compare them to determine the ones that provide the 'best solution' for recommendation to the customer/commander. To accomplish this, the team should complete the following steps:

- Review any remaining assumptions to ensure that they are still valid and if or how they will significantly impact or influence a COA. If it is determined that an assumption could invalidate a COA, the assumption should be resolved before further COA analysis.
- Develop evaluation criteria to evaluate the COAs against each other. The evaluation criteria are derived from information gained through mission analysis, technical expertise, experience, and any information that the customer has identified as critical or significant (see Table B-1). While there is no established number of evaluation criteria selected, the criteria should be limited to a manageable number and provide a degree of differentiation between the COAs."

Table B-1. Examples of evaluation criteria for site selection, land use planning, and general site planning.

Site Selection	Land Use Plan	General Site Plan
Soil Condition	Size	AT/FP Considerations
Probability of Natural Events	Security	Population Proximity
Water Availability	Functional and Operational (Affinity) Relationships	Site Access
Sewage	Utilities/Waste Disposal	Terrain, Slope, Drainage
Power Supply	Environmental Sensitivity	Existing Vegetation
Environmental Conditions	Sewage Treatment/Disposal	Prevailing Winds
Communications Availability	Training Areas	Climatic Orientation
Medical Facility Proximity		Affinity Relationship

- Analyze the advantages and disadvantages of each of the evaluation criteria against each of the COAs. In some cases, the advantages and disadvantages analysis may be subjective; however, a clear positive or negative for each of the evaluation criteria should be demonstrated.
- Weight the evaluation criteria based on the outcome of the subjective analysis and the customer's guidance, and compare the COAs using a decision matrix. The use of either a maximization or minimization chart is acceptable. Table B-2 provides a simplified example of a decision matrix using weighted evaluation criteria. In this example, the weighting has been designed to reflect the larger numbers (maximization chart) being the better COA.

Table B-2. Example decision matrix using weighted evaluation criteria.

Evaluation Criteria	Weight	COA 1	COA 2	COA 3
AT/FP Considerations	5	1(5)	2(10)	3(15)
Population Proximity	3	2(6)	1(3)	3(9)
Site Access	2	3(6)	1.5(3)	1.5(3)
TOTAL/Weight Total		6(17)	4.5(16)	7.5(27)

4-1.a.: "Mission analysis is an ongoing step that involves the study of the various factors, including the mission, the tactical and political situation, economic and cultural variables, specified standards, and available resources that can impact BCDP. It is the cornerstone of the BCDP process. Throughout the development of the base camp plan, planners constantly review facts and assumptions, react to unanticipated requirements and events, and refine the plan. These considerations are drawn from an analysis of the ***base camp's mission, size, and allowable standards and operationally related variables***. Even in circumstances where planners become involved in the process after it has already started, they must still integrate the original analysis, and continue to revisit it, as they proceed with their mission.

B.3.3 Log. General

B.3.3.1 ATP 3-34.40, General Engineering

Table B-3. Construction effort—facilities requirements (temporary to semi-permanent standard/template climate/wood frame).

Facility	*Size, in feet*	*Basis*	*Qty*	*Man-Hours*			
				Hor	*Ver*	*Gen*	*Total*
Shop, motor repair	48x48x14	1/100 veh	1	55	1,185	287	1,527
Storehouse	20x50x8	2 sq ft/man	1	32	461	136	629
Dispensary	20x60x8	1/500 men	1	33	1,290	115	1,438
Headquarters/unit supply	20x40x8	1/200 men	3	84	1,293	240	1,617
Barracks, 50-man	20x100x8	40 sq ft/man	10	450	7,510	1,860	9,820
Kitchen	Varies	1/250 men	2	154	10,352	3,788	14,294
Bathhouse/latrine	20x30x8	1 shower/10 men	1	24	941	61	1,026
Bathhouse/latrine	20x80x8	1 shower/24 men	1	39	1,754	150	1,943
Quarters (office)	20x100x8	80 sq ft/office	1	45	869	186	1,100
Guardhouse	20x60x8	1–250 men	1	33	626	115	774
Dayroom	40x60x8	5 sq ft/man	1	43	868	178	1,089
Power system	500 man	light/power	1	56	460	192	708
Boiler plant	Varies	1/2 dining/1/2 sleeping	1	208	4,112	1,200	5,520
Drainage	500 man	17.5 gpd	1	205	384	490	1,079
Water supply well	Varies	As required	1	396	45	230	671
Water tank	200 gal	As required	1		105	4	109
Water distribution	500 man	25 gpd/man	1	352	812	416	1,580
Sump fire	10,000 gal	effective radius, 500 feet	1	16	108	16	240

Legend:

gal	gallon(s)
gen	general
gpd	gallons per day
HOR	horizontal
qty	quantity
sq ft	square foot (feet)
veh	vehicle
VER	vertical

Table B-4. Motor park.

Base Camp Population	*Area in Square Feet*
500	61,760
*1,500	242,160
*3,000	541,200
*10,000	721,600

*Based on combinations of 500-man, 1,000-man, and 5,000-man estimates.

Table B-5. Soldier or Marine support facilities.

Facility	Criteria	Population			
		500	1,500	3,000	10,000
Dining	sq ft/person varies by unit size	NA	NA	NA	NA
Fire station	2.6 x size of vehicle + 90 sq ft	NA	NA	NA	NA
Detainee	250 sq ft/MP + 50 sq ft/confinee	NA	NA	NA	NA
Bakery	0.6 sq ft/person supported	300	900	1800	6000
Laundry	sq ft/person varies by unit size	4.4	4.4	3.3	3.0
Dry cleaning	sq ft/person varies by unit size	4.4	4.4	1.75	1.0
Chapel	1.785 sq ft/person	893	2,678	5,55	17,850
Craft/hobby	1 sq ft/person	500	1,500	3,000	10,000
Gymnasium	3.3 sq ft/person	1650	4,950	9,900	33,000
Library	0.75 sq ft/person	375	1,125	2,250	7,500
Service club	7.5 sq ft/NCO; 9.5 sq ft/officer	NA	NA	NA	NA
Post exchange	1.2 sq ft/person	600	1,800	3,600	12,000
Post office	sq ft/person varies by unit size	NA	NA	0.5	0.5
Theater	sq ft/person varies by unit size	NA	NA	5.5	5.5
Legend:					
NA	not applicable				

Table B-6. Covered/open storage requirements for 14 days of stockage.

Base Camp Population	Covered Storage, in Square Feet	Open Storage, in Square Yards
500	44	1,330
1,500	132	3,990
3,000	265	7,980
10,000	882	26,600

Table B-7. Cold Storage requirements for 14 days of stockage.

Base Camp Population	Class I, in Cubic Feet	Class VI, in Cubic Feet	Class VIII, in Cubic Feet	Class IX, in Cubic Feet
500	585	155	34	12
1,500	1,755	465	101	36
3,000	3,510	930	202	72
10,000	11,690	3,095	672	238

Table B-8. Fuel storage.

Base Camp Population	Diesel* (Barrels)	MOGAS* (Barrels)
500	160	600
1,500	480	1,800
3,000	960	3,600
10,000	3,200	12,000
*Assuming a stock objective of 8 days.		
Legend: MOGAS motor gasoline		

Table B-9. Soldier or Marine housing.

Base Camp Population	Officer, in Square Feet	Enlisted, in Square Feet
500	11,000	28,800
1,500	33,000	86,400
3,000	66,000	172,800
10,000	220,000	576,000
Note: Assumes 20/80 officer to enlisted ratio, 110 square feet/officer, and 72 square feet/enlisted.		

Table B-10. Selected tentage planning factors.

Tent Type	Floor Area, in Square Feet	Weight, Packed, in Pounds	Volume, Packed, in Cubic Feet
Tent, GP, small	198.9	163	26.2
Tent, GP, medium[1]	512.0	534	33.0
Tent, GP, large	936.0	665	69.0
Tent, expandable modular (temper)	640.0	2,192	200.0
Tent, maintenance, medium	640.0	1,798	62.0
[1]The Operation Joint Endeavor living standard was 10 Soldiers or Marines per each GP, medium, tent.			
LEGEND: GP general purpose			

B.3.3.2 FMI 4-93.2, The Sustainment Brigade

2-9. "… In coordination with the supporting AFSB and CSB CDR or principal assistant responsible for contracting (PARC), the sustainment brigade will participate in assessing and acquiring available host nation (HN) infrastructure capabilities and contracted support."

2-10. "Given the mission of theater opening, a sustainment brigade, together with TTOE, should have capabilities to conduct the following: …

- Establishing and operating staging areas and/or bases. …
- Identifying and occupying the real estate needed for marshaling areas and the theater staging bases …"

B.3.4 Log. Distances

B.3.4.1 ADP 4-0, Sustainment

61.: Operational reach is a necessity for successful operations. *Operational reach* is the distance and duration across which a unit can successfully employ military capabilities (JP 3-0). The limit of a unit's operational reach is its culminating point. ***Operational reach is facilitated by prepositioning stocks; capability to project Army forces and*** sustainment to an operational environment; to open theater ports; ***establish forward bases***; and to close a theater on conclusion of an operation.

66.: Basing directly enables and extends operational reach, and involves the provision of sustainable facilities and protected locations from which units can conduct operations. Army forces typically rely on a mix of bases and/or base camps to deploy and employ landpower simultaneously to operational depth. Options for basing span the range from permanent basing in CONUS to permanent or contingency (non-permanent) basing overseas. A *base camp* is an evolving military facility that supports military operations of a deployed unit and provides the necessary support and services for sustained operations (see Army doctrine on base camps).

B.3.4.2 FM 3-06, Urban Operations

4-74.: [Distances and Density] "***Distances in UO are compressed to correspond to the density of threat forces and noncombatants***. In open terrain, squads, platoons, and companies may be able to control or influence thousands of meters of space. In UO, large buildings can absorb the efforts of several companies or battalions. Crowds of thousands can assemble in areas of a few hundred meters requiring correspondingly large forces for control. Maximum engagement ranges, as influenced by the urban terrain, are usually closer. Units may require field artillery for direct fire at targets ranging fewer than a hundred meters. Commanders and staffs understand the telescoping nature of the battlefield, the density of threat forces, and the density of noncombatants. In addition to the actual conduct of urban tactical operations, these factors will directly affect training, planning, force deployment, and strength.

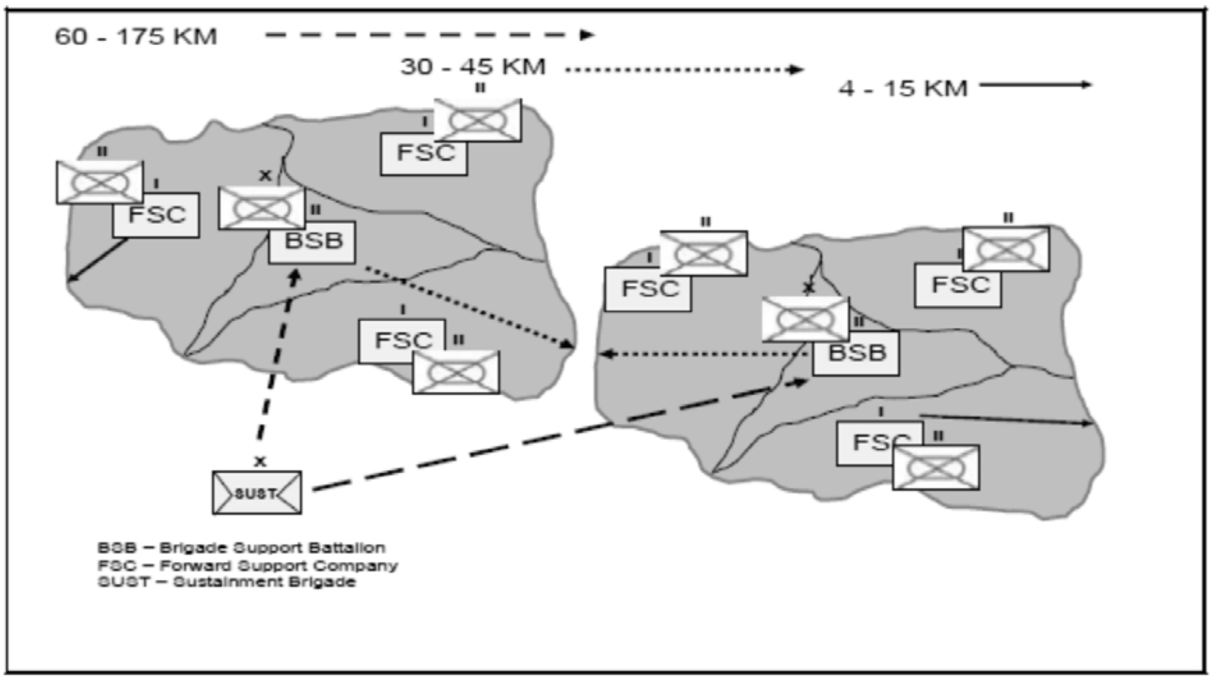
4-75. ***Time-distance considerations are especially important throughout planning cycles***. Though distances may be short, the physical nature of the environment can drastically change the planning factors for unit movements. The advance of a battalion may be measured in hundreds of meters per day. Thus, all time and distance calculations that relate to sequencing of forces, synchronizing combat power and other capacities, and making decisions require reevaluation based on the urban conditions.

10-4.: "Survivability is being able to protect support functions from destruction or degradation. Commanders often choose to locate sustainment functions in an urban area because the buildings may better protect and conceal equipment, supplies, and people. ***Urban industrial areas and airports are frequently chosen as support areas because they offer this protection as well as sizeable warehouses, large parking areas, and materials handling equipment (MHE)***. Such areas facilitate the storage and movement of equipment and supplies. They may also provide readily available water, electricity, and other potentially useful urban resources and infrastructure. However, these ***areas may also contain toxic industrial materials (TIM)*** (see Chapter 2). These materials and chemicals in ***close proximity to support areas may unjustifiably increase the risk to survivability***. Sustainment activities in any environment will always be targeted by threat forces. Furthermore, sustainment activities located in any type of ***confined urban area can offer lucrative targets for terrorists, insurgents, or even angry crowds and mobs***. Therefore, no sustainment activity should be considered safe from attack during UO. (During OPERATION JUST CAUSE, Panamanian paramilitary forces and deserters even attacked marked ambulances). Although host-nation support may include assets to assist in defending sustainment units, bases, and lines of communications (LOCs), sustainment commanders must carefully consider if adequate protection measures can ensure survivability. The sustainment commander's greatest challenge to force protection may be complacency born of routine.

B.3.4.3 FMI 4-93.2, The Sustainment Brigade

2-25. As a general guideline, in order to prevent overreach of units in tactical environments, the recommended distance between a Sustainment Brigade and the BSBs it supports should be from 60 to no more than 175 KM (see Figure B-2). The 175 KM limit reflects one line haul trip a day (max 222 KM-20%= 177 KM), and is constrained by fuel consumption of the distribution platform(s). The lower distance of 60 KM reflects line haul in rough terrain (6 hr x 10 KM/hr). For both, the assumption is that the ***longest time a driver can continuously and safely drive in a shift is 6 hours*** (one way trip). There is also an assumption of two drivers per vehicle. Ideally, the BSBs should be from 30 KM to 45 KM from combat operations and the FSCs should be from 4 KM to 15 KM from combat.

Figure B-2. Operational distances.



2-26. The following considerations should be used in determining operational distances:

- Sustainment Brigade’s will locate near major transportation nodes (airfields, rail heads, inland, water ports).
- There are no CSCs inside a division’s assigned area of operation.

- Line haul convoys will not normally be refueled by BSBs.
- Distances are constrained by the vehicle with the heaviest fuel consumption.
- Distribution platforms should return with a 20 percent capacity fuel safety margin.
- The longest time a driver can continuously and safely drive in a shift is 6 hours.
- Critical items are distributed via throughput (normally by air).
- Sustainment Brigade's schedule of line haul replenishments to BSBs.
- Poor roads reduce travel time by half from that of good roads.
- Night driving reduces travel time by half from day driving.

B.3.5 Log. Water

B.3.5.1 ATP 3-34.40, General Engineering

12-14.: "***Water support requirements*** are considered in the initial phases of each military operation. The planning for water is initially based on the sustainment preparation of the operational environment. Logistics planners use FM 10-52 to estimate the required quantity and quality, based on the mission, size of the supported force, dispersion of forces in the AO, and availability of various sources of water supply.

Table B-11. Summary table—base camp aggregate requirements.

Base Camp Population	*Fine Aggregate, in Cubic Yards*	*Course Aggregate, in Cubic Yards*
500	450	620
1,500	1,700	2,485
3,000	3,320	4,820
10,000	11,200	16,066

Table B-12. General planning factors for potable and nonpotable water requirements.

Consumer	*Rate of Consumption*	*Remarks*
Individual	3–6 gpd/per man	NA
Base camp (basic-enhanced)	20–50 gpd/per man	Include waterbome sewage
Vehicles (tactical)	1/2–1 gpd/per vehicle	NA
Support Facilities		
Hospital	200 gpd/per bed	20-hour operation
QM laundry company	64,000 gpd	20-hour operation
Construction Equipment		
Road construction	10,000 g/km	Nonpotable, clean
Rockcrusher	22,500 gph	Nonpotable, clean
Concrete mixer	560gph/140 gph	Nonpotable, clean
Other Considerations		
Sewage treatment requirements	2.5 gpd/per man	Nonpotable, clean

LEGEND:

g/km	gallons per kilometer
gpd	gallons per day
gph	gallons per hour
QM	quartermaster

B.3.6 Operational Requirements

B.3.6.1 ADRP 3-0, Unified Land Operations

4-37.: "***Forward operating bases may be used for an extended time and are often critical to wide area security***. During protracted operations, they may be expanded and improved to establish a more permanent presence. The ***scale and complexity of the forward operating bases, however, directly relates to the size of the force required to maintain it***. A large forward operating base with extensive facilities requires a much larger security force than a smaller, austere base. Commanders weigh whether to expand and improve forward operating bases against the type and number of forces available to secure it, the expected length of the forward deployment, and the force's sustainment requirements."

B.3.6.2 EP 1105-3-1, Base Camp Development in the Theater of Operations

2-2.b.(2): "*Location selection*. Finding the best possible location for the base camp requires balancing tactical and operational requirements and the ability to sustain the camp with terrain factors such as urban or rural areas, drainage soils, vegetation, and topography.

In some cases base camps may be located on existing facilities. In other cases they may be located on undeveloped land. In either case, it requires a careful balancing of requirements to obtain the best location that meets operational, sustainability, and engineering requirements...”

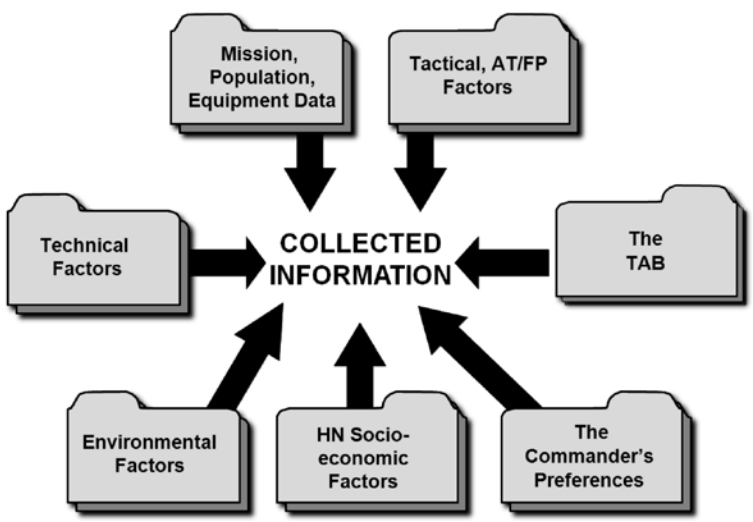
2-2.b.(3) “*Land use planning*. Although land use planning begins in the early stages of the BCDP, it requires the planner to conduct a facility requirements analysis before it can be finalized. Additionally, since land use can be impacted by the site selected, the planner should confirm that the location selected is adequate and has been approved for the base camp. This step in the process integrates the military units’ requirements (such as survivability measures, housing, motor pools, and storage areas) with land use affinities and terrain restrictions. It provides a general overlay of land use areas within the proposed base camp (see Chapter 6).”

2-2.b.(4): “*Facility requirements development*. Facility requirements reflect the integration of facility allowances with unit requirements. Allowances are based on the type of unit, its size, and the anticipated life span of the base camp. These allowances are found in the theater-specific guidance documents such as the Sand Book and include areas such as square feet of housing space, square feet of command space, and allowances for specific facilities such as chapels and movie theaters. JP 3-34 provides guidance related to facility standards. Once allowances have been determined, they are reconciled with specific unit requirements by validating or adjusting those requirements based on specific unit needs. For example, the Sand Book may specify a certain amount of square feet for vehicle parking. Coordination with the unit, however, may reveal that they have specific requirements, such as turning pads for armored vehicles. In addition, the theater guidance documents do not take into account every unit requirement. Coordination with the unit may reveal, for instance, that they have water purification units with specific needs. Planners must work with the customer to reconcile what is allowed versus what is required (see Chapter 7). Adjustments to these allowances must be justified.”

3-2.b.: “*Mission analysis or collect and analyze data*. Mission analysis is crucial to planning as both the process and the products assist planners with situational awareness and determining the scope of their mission. Determining the military mission, the number and type of camp occupants, the primary function of the base camp, and the commander’s intent will provide the planner a frame of reference to begin base camp development. It is a continuous process of updating and evaluating new or discovered data. ...”

6-3.a.: “Collect information. This step involves the collection and data analysis/evaluation process that was discussed in Chapters 3 and 4. The information essential for the preparation of the land use plan would include the mission, population, and equipment data; an analysis of the HN information; the EBS (and EHSA if available); the TAB; as much imaging and map data about the location as can be obtained; and command and operational planner guidance and preferences (see Figure B-3). One way to organize the collection task is to group the information into sets of planning factors as follows:

Figure B-3. Data essential for successful base camp land use planning.



6-3.c.: “Calculate land area requirements. Calculating land area requirements is a task that establishes the scope or size of the land use plan. Specifically, it estimates the required minimum size of each land use zone based on the size of the unit, mission, requirements, and other factors identified during the mission analysis. (See Appendix E, Table E-2 [page E-7], for general land use planning

factors.) Typically, an expansion factor to accommodate both known and unknown future expansions of the base camp is added to the applicable zones."

7-2.b.: "Analyze the mission. Before starting the process, the facilities allowances that were identified during the preliminary planning step are used as the starting point for a dialogue between the planning team, the prospective base camp users and, if possible, the HN's representative(s). In addition to the mission and population data derived from available OPORDs, MTOEs, TDAs, and standard databases, representatives from the units being assigned to the proposed base camp can provide and/or confirm critical unit strength and special support requirements data. Factors such as the mission, the population, the number and type of vehicles and equipment, the terrain, the climate, the EBS, and the planned life span of the base camp, will have a considerable impact on the base camp's facilities requirements."

9-3.d.(4): "... The location of a facility's footprint within an appropriate land use area is based partly on the mission and functional requirement for that facility and partly on the siting principles presented later in this chapter. The analysis involved in plotting a site will vary, depending on the complexity and scope of the facilities being sited.

9-3.e.(5): "AT/FP, environmental, and safety restrictions. Restrictions such as explosive

quantity safety distances, noise contours, airfield and helipad safety zones, historical buildings or places, archeological sites, sensitive natural areas, unsuitable soils, and range surface danger zones should be considered when siting proposed buildings and facilities.

9-3.e.(5)(a): "The importance of AT/FP standards cannot be stressed enough. Planners should review applicable AT/FP UFCs such as UFC 4-010-01, UFC 4-010-02, the Joint Forward Operations Base Force Protection Handbook (JFOB), Graphic Training Aid (GTA) 90- 01-010, and combatant command standards (Red Book and Sand Book), and consult with AT/FP experts such as

those at the USACE Protective Design Center (see Appendix G, Figures G-3 and G-4 [pages G-6 and G-7], for sample standoff distance and building separation diagrams).

9-4.: "Utility and Other Supplemental Plans. Once the recommended BDSP has been finalized by the planning team with assistance from design engineers (if they are not already team members), the team plans the layout of all primary, secondary, and tertiary utility lines in order to provide the appropriate services to each building and facility. Sites for the proposed water and wastewater treatment plants and solid waste disposal should already be located on the BDSP, but an additional check by the experts is advisable. Communications personnel often will call for site adjustments to meet the operating requirements of their equipment."

9-4.c.: "Per capita consumption, demand, and production rates for utility systems are established by theater standards criteria and allowances."

9-4.e.(1): "The number of authorized personnel of the base camp's assigned units... (contained in MTOE or TDA) In a TO situation, the required population and equipment density should be used.

9-4.e.(2): The number of personnel who are not listed on an MTOE or TDA for the units assigned to the base camp. These could include allied or coalition forces assigned to the base camp, nonappropriated fund (NAF) personnel such as community club employees, HN employees, civilian personnel displaced by military operations or emergencies, and contractor personnel.

9-4.e.(3): The number of personnel consisting of portions of any of the two previous categories who would be considered as fractional individuals."

B.4 Land use planning factors

Table B-13 provides some initial planning factors to assist the planner with calculating land area requirements for an HBCT-sized element.

Table B-13. General base camp land use planning factors.

Land Use	Area (in acres)	Suggested Range (in acres)	Facilities Included	Remarks
Industrial	155	150-160	Wastewater treatment, electrical generation, incinerator, vehicle maintenance	
Community/ Administrative	99	90-110	Medical, fire and rescue, postal, dining, headquarters, briefing/chapel, parade field	
Troop Housing	230	225-250	Housing, showers, latrines, bunkers	Includes expansion capability (surge areas).
Supply/Storage	453	430-460	Military vehicle parking, wash racks, ammunition storage, open storage	
Morale/Welfare/ Recreation	65	50-75		
Heliport Facilities	129	110-130	Heliport aprons, tie-down area, maintenance hangar, operations, control tower, available fuel storage and truck parking, radar site	This is for a heliport of 12 helipads. If only one helipad is needed, less land would be required.
Open Space/Buffer	703	650-850	ECPs, guard towers, AT/FP buffers	Includes 350 acres of clear space outside the security fence.
Contractor Area	108	75-150		

Table B-14. Examples of inventory data.

Attribute	Measure or Qualification
Land	Area(s), names and dimensions
	Description of terrain, vegetation, and such
	Present use or use before U.S. presence
	Use(s) by U.S. forces
	Planned use after U.S. redeployment
	Operational and AT/FP considerations
	Environmental aspects/vulnerabilities
	Projected date of U.S. return to owner(s)
Buildings	Building number or letter designation
	Gross area
	Capacity, if applicable
	Designed use
	Year built
	Type of construction
	Conformance with AT/FP standards
	Condition of each building system
	Installed equipment
	Utility support (to each building)
	Projected date, method of disposal or turnover
Infrastructure	Name, number, or letter designation
	Length, area, and such
	Type of construction
	Capacity or capability
	Projected date, method of disposal or turnover
Utility systems	Each component name, number, or letter
	Length, area, and such
	Type(s) of construction/material used
	Capacity or capability, each component or subsystem
	Operational and AT/FP considerations and vulnerabilities
	Projected date, method of disposal or turnover

Table B-15. Operational requirements that produce functional requirements.

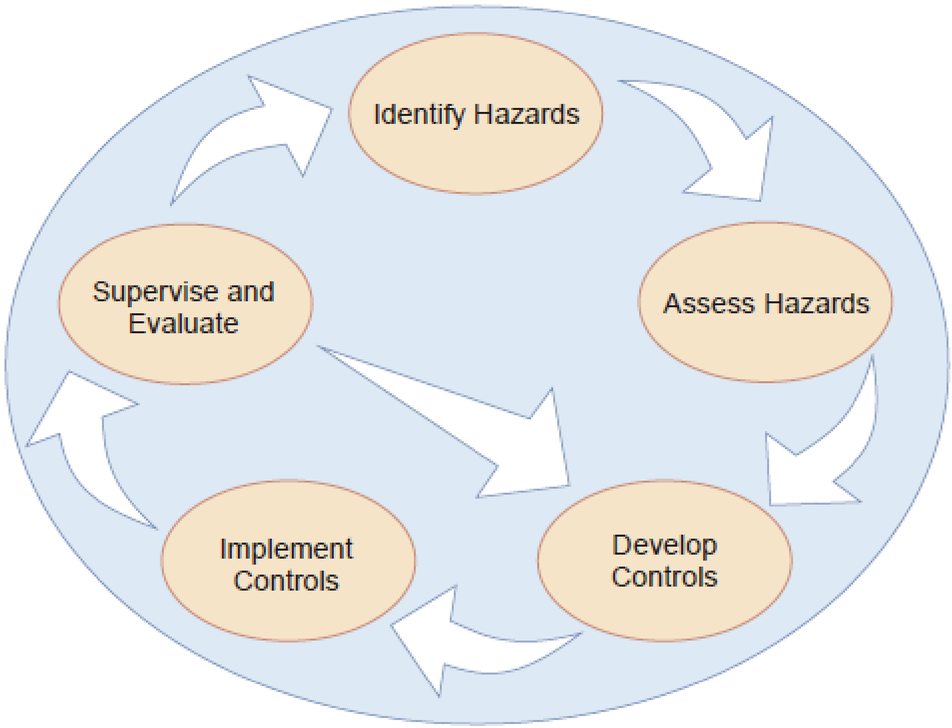
Operational Requirements	Functional Requirements
Assigned armor units need ammunition storage capacity for two basic loads.	The ammunition storage quantity/density will be increased to account for armor unit requirement. Increased quantity/safety distance is required.
New facilities construction will be accomplished by contract method.	Contractor housing, administrative, plant, storage, disposal areas, and haul routes are required.
Operating artillery and air defense systems will be located within the base camp land area but separate from built-up areas.	Add requirements for fire support bases to appropriate facility categories, such as remote housing, service member support, hardened ammunition holding, and AT/FP structures. Add this ammunition requirement to the required ASP capacity.
Rotary wing aircraft operations require "hot" refueling and rapid reloading of weapons systems.	AHA and fuel storage/pumping are required at airfield—close but cannot violate safety criteria.
Some assigned units have male and female service members.	Typically requires separate living, latrine, and shower facilities for each gender.
Air assault rapid reaction mission requires that an infantry company be deployed by rotary wing aircraft within 30 minutes, followed by a larger force.	The airfield should be within reasonable distance of troop housing via multiple access routes. A marshaling area; a command, control, and communication building; and a briefing building are required at the airfield.
Units will carry enhanced prescribed load list, spare parts, and components.	Parts storage areas in maintenance facilities should be increased.
Operations require rapid reaction combined arms battalion force.	Tracked-vehicle hardstand designs need multiple exits to area of operations that are ideally separated from wheeled-vehicle traffic.
BCT and battalion commanders C2 some operations from rotary wing aircraft.	Sufficient helipads should be located close to HQs and C2 facilities.
Base camp security will include mounted patrols around the base camp perimeter.	A paved perimeter road will enhance efficiency of patrols. Add this to requirement for paved roadways.
Because of its location on the MSR, transportation units will use the base camp as convoy offloading and/or stopover point.	Semitrailer truck aprons are required at warehousing facilities. Secure hardstand and driver/crew housing is required for overnight stopover of convoy trucks and security vehicles.

B.5 Other Considerations

B.5.1 Risk Management

B.5.1.1 JP 3-0, Joint Operations

Figure B-4. Risk management process.



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The U.S. military may be required to operate in dense urban and megacity environments, which may pose significant challenges for contingency basing. This work reviews and analyzes the potential disconnect between existing doctrine, standard operating procedures, and the human geographic reality of dense urban environments and megacities as concerns contingency basing. The work: (1) characterizes 41 projected megacities using the Army Chief of Staff's Strategic Study Group's megacity typology, (2) performs crosswalk analysis between this characterization and existing contingency basing doctrine, (3) details doctrinal gaps, specifically those pertaining to site selection, logistics, and security, and (4) recommends future research to alleviate those gaps.

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